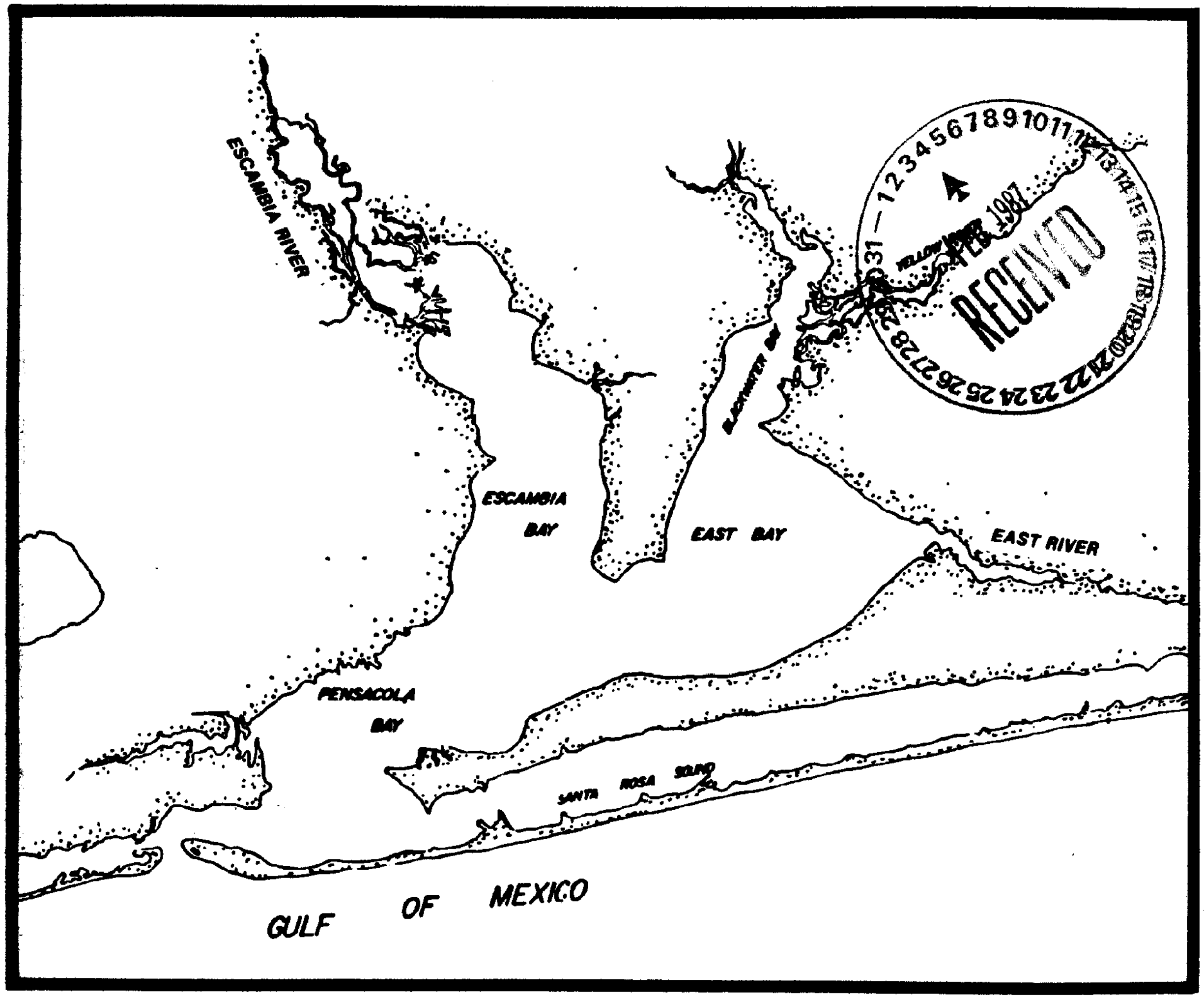
CM-134

The Pensacola Bay System



An Analysis of Estuarine Degradations
and their Relationship to Land Management Practices

Florida Coastal Zone Management

Florida Department of Community Affairs
Tom Lewis, Jr., Architect, Secretary

November 1986

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EXECUTIVE SUMMARY

This study was in direct support of the efforts of the Escambia/Santa Rosa Coast Resource Planning and Management Committee established pursuant to Section 380.45, Florida Statutes and more specifically the Bay Area Resource Inventory Program. A critical issue addressed in the Resource Management Plan adopted by the committee was "The adequacy of environmental resource protection, particularly for coastal dunes, wetlands, and estuarine systems in the study area." Three primary objectives were outlined in the plan that relate to this issue: (1) the protection of estuarine systems, wetlands, and marsh areas from ill-advised development to ensure that their productivity is not impaired; (2) the protection of the unique environmental features of barrier islands, including the beach and dune system, and; (3) the development of existing and future wastewater and stormwater management systems in a way which will minimize environmental impacts. The recognition of recurring degradations within the system and their relationships to management practices for the surrounding uplands provides a focus for recommended changes in the system's regulation.

The primary purpose of this study was to perform an interdisciplinary (i.e., scientific and regulatory) analysis of the Pensacola Bay system in order to: 1) evaluate the relationship of previous land management practices to degradations documented in the estuarine system, and; 2) recommend specific management practices for the upland regions surrounding the system. The steps taken in this process were: 1) identification of historical problems and affected regions in the bay; 2) identification of jurisdictional and regulatory agencies and local governments with responsibilities in the system; (3) outline of past land management and land use practices; (4) development of relationships between estuarine problems and land management practices, and; 5) development of recommendations for corrective action. The report provides the Bay Area Resource Inventory program within the Resource Management Plan an initial starting point in their efforts to compile historical data on the bay system.

The Pensacola Bay system presents unique problems for management because it is comprised of five separate main water bodies (i.e., Blackwater Bay, East Bay, Escambia Bay, Pensacola Bay, and Santa Rosa Sound) and numerous small bayous and inlets that circumscribe the system. In addition, approximately 90 percent of the watershed of the major freshwater input, the Escambia River, lies outside the state in Alabama to the north, which creates an additional level of management problems.

As the estuarine system is comprised of numerous components, the management of the surrounding uplands is fragmented amongst a multitude of federal, state, and regional regulatory agencies, as well as numerous local governments bordering the system. Present-day management is accomplished through the uncoordinated implementation of various monitoring, permitting, and regulatory programs. In addition, many of these programs are reactive rather than proactive in nature, a critical situation given the growth pressure that this region has been experiencing and will experience in the future.

Under the existing management framework, jurisdictions may overlap, interests often conflict, policies are inconsistent such that environmental safeguards made in one area of a watershed are not uniformily applied throughout the entire watershed, and no single agency has overview authority for the bay or manages it as a complete natural resource. There is a need to establish management boundaries and clearly define regulatory mechanisms for the estuary because the system can never be comprehensively managed without determining and controlling the impacts of those activities occurring upstream from, or adjacent to, the estuary. An overall goal of this study is to guide the development of a consistent set of planning policies and performance standards common to the local governments that are present in the system.

The format of this report is set up as follows. First, a general description of the bay and surrounding uplands (e.g., geology and physiography) is given. Second, a discussion of the major problem areas (e.g., habitat and water quality declines) within the system is presented together with possible causes suggested by various investigators. Third, the existing regulatory and jurisdictional framework for the system are presented. Fourth, these two are discussed together and relationships drawn. Finally, recommendations are made such as necessary revisions to comprehensive plans and ordinances and intergovernmental coordination to help correct the documented problems. The report also includes a comprehensive bibliography of reports and research conducted within the Pensacola Bay system.

Six major problem categories are delineated in the Pensacola Bay system: (1) aquatic vegetation declines; (2) shellfish and finfish declines; (3) water quality degradations; (4) estuarine sediment contamination; (5) bayou-specific problems, and; (6) shoreline erosion. These are tied to alterations in environmental conditions such as increased turbidity or sedimentation. Relationships are presented between land management practices, such as stormwater regulation, and environmental conditions that are affected by them based upon work conducted within the Pensacola system as well as other systems. In this manner, management practices are then tied to actual estuarine resource declines.

The recommendations presented are mindful of the guidelines and requirements of Chapter 163, Florida Statutes and the Resource Management Plan. The measures include zoning throughout both counties; mapping exisiting and future land uses; establishing a sensitive area buffer along the bays, bayous and rivers; coordination between the utility boards and authorities and the Department of Health and Rehabilitative Services; establishing an adequate facilities ordinance; establishing a watershed management district program; preparing an adequate vegetation ordinance; establishing a marina siting procedure; and reconsidering how the policies of the comprehensive plans could address the need for a higher level of performance in existing ordinances suggested for revision.

One of the objectives of this study is to create a process whereby the regulations and activities carried out in estuarine areas throughout Florida could be evaluated in a similar fashion. Subsequently, the regulatory mechanisms in place within these systems could be modified so that they could be administered in a more efficient and uniform manner. The results of this report will be of direct benefit to the local governments in the system that are required to comply with s. 163.3177 (9) (d) Florida Statutes, which states that "certain bays, estuaries, and harbors that fall under the jurisdiction of more than one local government are (to be) managed in a consistent and coordinated manner in the case of local governments required to include a coastal management element in their comprehensive plans pursuant to s. 163.3177 (6) (g)."

The application of this process, moreover, can reveal data gaps in estuarine and upland resources. This could lead to more efficient and directed sampling programs and the recognition of jurisdictional conflicts or lack of regulatory mechanisms which could be modified to improve policy implementation.

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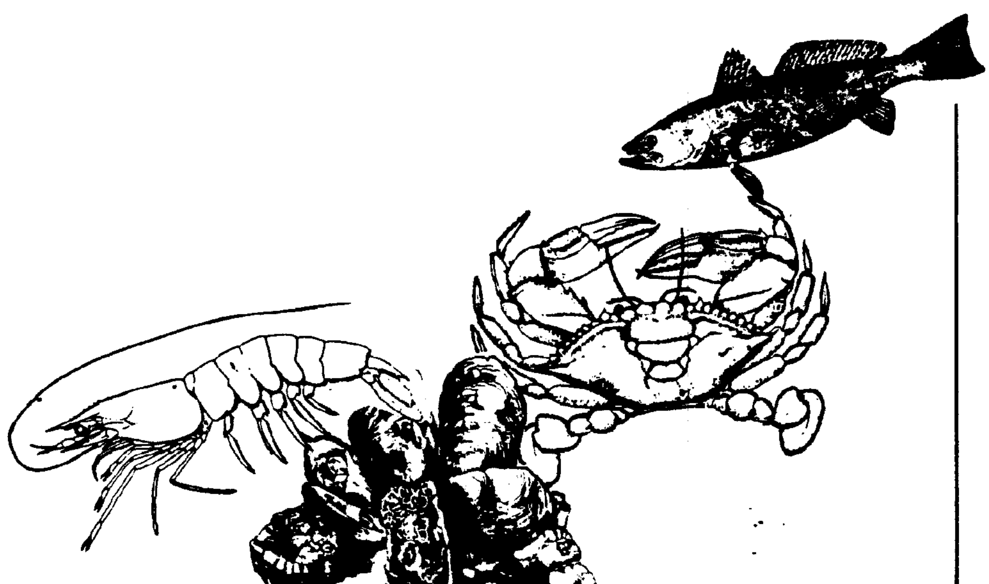


Section-1 Marine Research Data Base

Section 1. Marine Research Data Base

1.1 Introduction

The information for this section of the report was gathered from a variety of sources: published and unpublished reports, interdepartmental memos from state agencies, and personal communications with various individuals.

The format of this section of the report is set up as follows. First, a general description of the region is given. Second, the major problem categories are outlined and discussed. Historical trends are noted as well as the most likely causative factors as identified by previous investigators. We supply an extensive bibliography at the end of the report which includes all the reports and citations we encountered during the research of this report relating to the bay system.

1.2 System Description

The Pensacola Bay system is located within Escambia and Santa Rosa counties in the northwest Florida Panhandle and is comprised of 5 main subsystems: 1) Blackwater Bay; 2) East Bay; 3) Escambia Bay; 4) Pensacola Bay, and; 5) Santa Rosa Sound. It is the fourth largest estuary in Florida (Figure 1.1). Its surface area covers approximately 126,000 total acres.

We defined our study area as the Pensacola "estuarine system" which includes the 5 subsystems noted above and their watersheds. The estuary is defined as all or part of the mouths of the rivers, streams, and semi-enclosed body of water (such as a bay, sound, or lagoon) that is connected with the sea and undergoes continuous or periodic dilution with freshwater runoff from the land.

The estuary (or 5 subsystems) extends 20 miles inland and comprises approximately 550 linear miles of coastline and 270 miles of inland waterways.

Three major rivers flow into the system: the Escambia, Blackwater, and Yellow Rivers. The Escambia River is the largest in the system and the fifth largest in Florida. It enters the upper northwest area of Escambia Bay. It is 240 mi long and its basin covers 4,233 mi^2. The Yellow River is the second largest in the system and enters the northeast end of Blackwater Bay. It is 110 mi long and its basin covers 1,365 mi^2. The Blackwater River enters the north tip of Blackwater Bay and is 62 mi long. Its basin covers 860 mi^2. Freshwater inputs are critically important to the estuary both for the nutrients they introduce

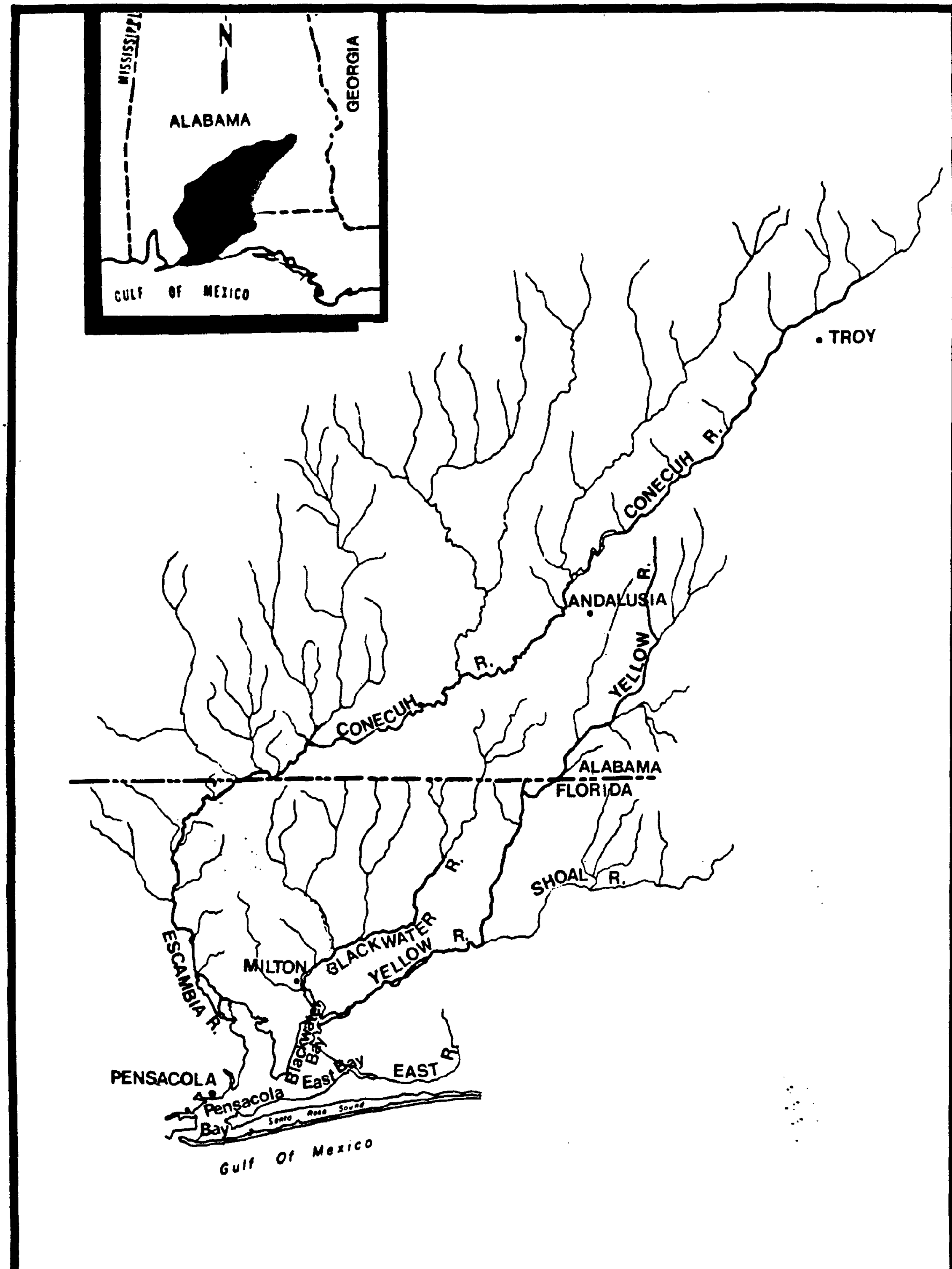


Figure 1.1 Pensacola Bay system watershed

and for the pollutants they flush out. Generally, March and April have the highest mean monthly discharges, while September, October, and November exhibit the lowest mean monthly discharges.

a. Geology and Physiography

The system was created during the past 11,000 years when the surface drainage basin was "drowned" by rising sea levels (Marsh, 1966). The bay system and surrounding lands lie in the Coastal Plain physiographic province that consists chiefly of unconsolidated sands, limestones, silts, and clays of Cretaceous to recent age. The most distinctive topographic features in the region are the Pleistocene marine terraces (Marsh, 1966). Remnants of the terraces are evidenced in Escambia and Santa Rosa Counties by upland plateau, flat-topped hills, low coastal plains, and benches along the rivers and bays.

The Coastal Plain Province is divided into two distinct topographic subdivisions: 1) the Coastal Lowlands, and; 2) the Western Highlands. The Coastal Lowlands are characterized by poorly drained, nearly level plains lying less than 100 ft above sea level. The Western Highlands consist of a southward sloping plateau with elevations over 200 ft whose surface has been cut by numerous streams (Marsh, 1966). The Coastal Lowlands occupy the floodplains of the Escambia, Blackwater, Yellow, and East Rivers, which are meandering slow-moving streams, with only a slight gradient in their lower regions. The Western Highlands are found in the upland regions where the deeply cut tributaries of the Escambia, Blackwater, and Yellow Rivers originate.

The subsurface geology of Escambia and Santa Rosa Counties has more in common with the central Gulf coast of Alabama, Mississippi, and Louisiana to the west than it does with the geology of peninsular Florida to the east. Only two peninsular Florida units are present: the Tampa formation and Ocala group.

b. Bathymetry

The bay system has depths greater than those usually associated with bar-built estuaries. Maximum depths in Pensacola Bay range from 14 m near the opening to the Gulf and 7 m near East and Escambia Bays. Approximately 37% of the system has a MLW depth between 1.8 and 3.7 m, 37% is greater and 26% less than this range (Ketchen, 1979).

Table 1.1 Surface area, volume, and depths from specific regions in the Pensacola Bay System (after Olinger et al., 1975).

Subsystem	Surface Area (km^2)	Volume (10^6 m^3)	Mean Depth (m)
Pensacola Bay			
Pensacola Bay	133.6	793.8	5.9
Bayou Grande	3.8	10.3	1.7
Bayou Chico	1.1	2.0	1.8
Bayou Texar	1.5	2.8	1.9
Escambia Bay			
Escambia Bay	92.6	225.7	2.4
Mulatto Bayou	0.9	1.4	1.5
Blackwater Bay			
Blackwater Bay	24.6	47.1	1.9
Catfish Basin	0.9	1.1	1.2
East Bay			
East Bay	109.4	259.3	2.4
East Bay Bayou	4.5	5.3	1.2

c. Hydrodynamics

It is generally acknowledged that in order to properly manage a bay, there must be an understanding of the physical processes responsible for the dispersion and flushing of pollutants that are introduced into the system. Several investigators have reported on various aspects of the hydrodynamics of the Pensacola Bay system (Escambia Bay - Olinger et al., 1975; Edwards, 1976, and; Pensacola Bay - Ketchen, 1979).

The mean water temperature in the system has a normal seasonal range of approximately 16.5 °C (from 13.5 °C in January to 30.0 °C in July and August). Temperatures show the presence of two layers in the bay, separated by an occasional, very intense pycnocline (or density gradient). During the late summer and early fall, the system is nearly thermally homogeneous.

The system has diurnal tides predominately with a single high and low stage occurring each cycle. The average tidal range is 1.3 ft. Weather events can modify the tidal range in the system. Tropical storms can increase the tidal amplitude, while strong northern winds can suppress the tidal range. The diurnal nature of the tides, along with the low tidal amplitude, limit the flushing capabilities of the system. An estimated 18.8% of the system's volume is exchanged during each tidal cycle and flushing of the entire system takes approximately 18 days (Little and Quick, 1976). Olinger et al. (1975) suggested that the normal flushing time for Escambia Bay is 34 days but that variations of tidal mixing and river inflow can raise this value to 200 days.

The Pensacola Bay system is situated along a coastal region that has perhaps the least amount of tidal energy present to drive circulation of almost any coastal location in the Gulf of Mexico (Olinger et al., 1975). The low tidal energy results from the low mean tidal range and the diurnal frequency of the tides.

Individual Bay Discussion.

The hydrodynamics of two individual bays in the system, the Escambia and Pensacola, have been examined. A discussion of them follows:

Escambia Bay.

The cross-sectional area of the bay increases approximately 5 times from the upper portion to the entrance of the bay into Pensacola Bay. Escambia Bay is a partially mixed estuary (Edwards, 1976).

Tidal fluctuations primarily determine the currents and salinity distribution in the bay. The vertical salinity gradient is greater during the ebb tide (11 ppt m^{-1}) than on flood tide (5 ppt m^{-1}). Surface-wind stress has a dominant effect on mixing the upper layer and on surface currents, particularly when the winds are from the southeast and southwest. Under windy conditions (> 7 m s^{-1}), the halocline (or vertical salinity gradient) is much weaker (6 ppt m^{-1}) and deeper (3 m) than under calm conditions (20 ppt m^{-1} at 1 m) especially in the central and lower bay portions. The bridges crossing Escambia Bay (i.e., US 90, I-10, and the L&N RR) provide wind barriers to the upper region from southerly winds.

Stratification intensity decreases as river discharge decreases. River discharge affects circulation and salinity distribution in the surface water layers.

The geography of the basin causes a clockwise surface circulation and couterclockwise bottom circulation. The freshwater stream flows east-southeast from the Escambia River mouth and turns clockwise, while weakening as it moves down the bay. The flood tidal stream flows through the deep portion of the bay mouth in a northeasterly direction and turns counterclockwise as it moves up the channel (Figure 1.2). South of the I-10 bridge, the outflow generally has south and west components, whereas inflow components are north and east.

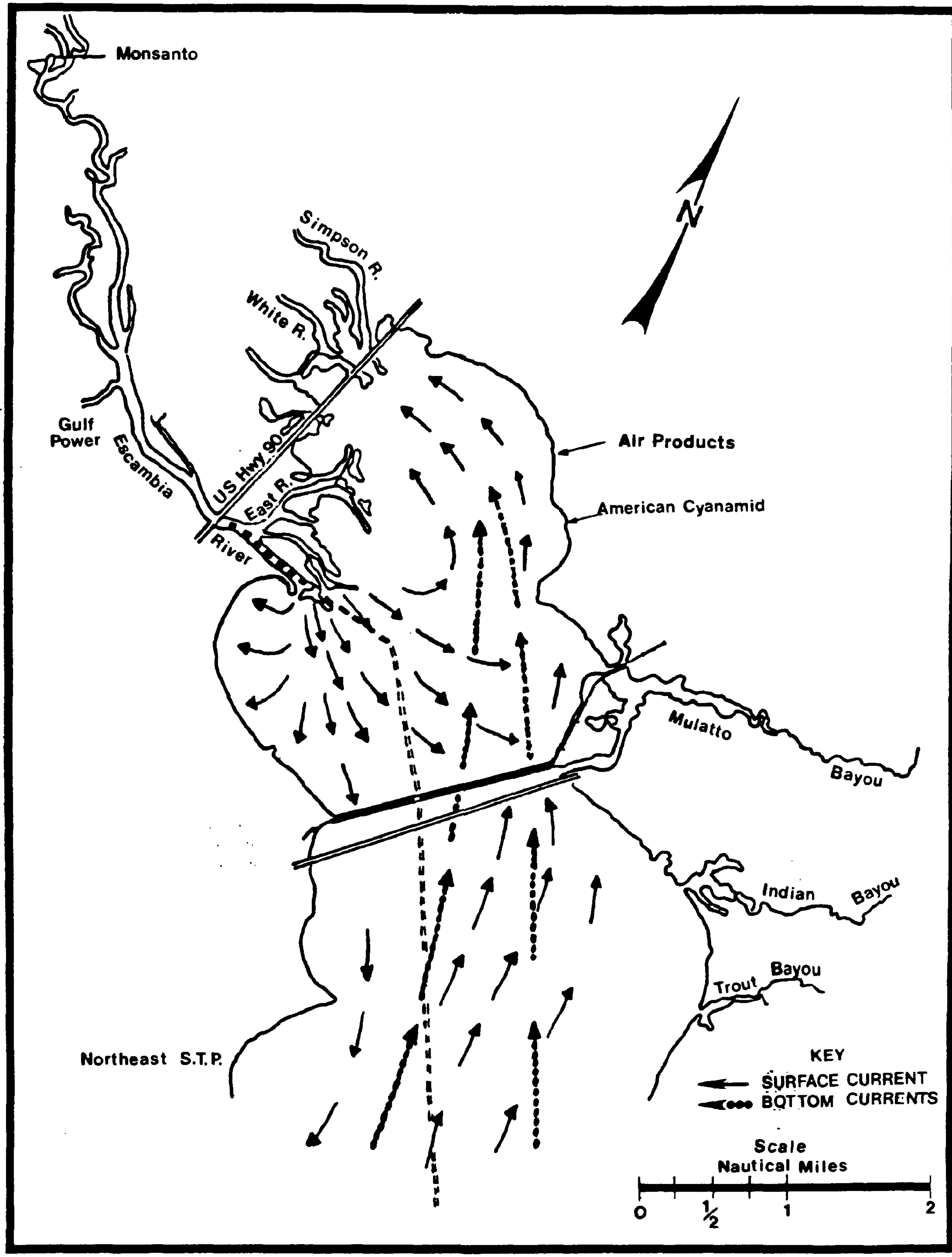


Figure 1.2 Floodtide currents within Escambia Bay.

Mean horizontal salinity gradients decrease from 1 ppt km^{-1} at the head to 0.5 ppt at the mouth of the bay. From the west side to the east, the mean gradient is about 1.0 ppt km^{-1}. A sharp vertical salinity gradient (18 ppt m^{-1}) varying in depth from 1 to 3 m generally occurs under high river discharge and ebb tidal conditions. Ebb tidal current patterns are shown in Figure 1.3.

Circulation is generally related to the salinity distribution but stratification does not necessarily reflect circulation patterns. Inflow is generally at its maximum within or below the halocline. Outflow is at a maximum above the halocline but not necessarily at the surface due to varying wind conditions. The largest instantaneous volume transport (1,520 $m^3 s^{-1}$) occurs during a spring ebb tide with a northerly wind.

Pensacola Bay.

Pensacola Bay is a drowned river valley/bar-built estuary. The primary hydrologic link between the bay (as well as the entire system) and the Gulf of Mexico is restricted to a break in Santa Rosa Island. The opening is only 800 m wide with a cross-sectional MLW area of 8,750 m^2 at the narrowest point and a mean depth of 10.9 m.

Vertical mixing in the bay is generally restricted by the unusually intense stratification. The bay is nearly always stratified (with respect to salinity) from near salt-wedge conditions (i.e., strong vertical stratification) to weak stratification. Severe stratification can occur: surface salinities as low as 0.6 ppt have been recorded off Pensacola's Municipal Pier with bottom salinities near 25 ppt (McNulty _et al_. 1972). Bottom salinities generally vary over a small range (approximately 5 ppt) while surface salinities are subject to wide variations (up to 25 ppt) during the year.

General circulation in the bay tends to keep to the right or follow the primary channel. Water entering the system from the Gulf on the flood tide tends to keep to the south side of the bay, and during ebb tide the strongest seaward flows in the bottom layer appear to move toward the north side of the bay. Wind greatly affects or can completely reverse the flow pattern. The wind has a major role in establishing the bay's circulation, not only in the surface layer but it has a dominant effect on circulation at all depths.

Olinger _et al_. (1975) noted that: "A pollutant having a high density, between freshwater and Gulf water, discharged under 'normal' environmental conditions in the central or upper reaches

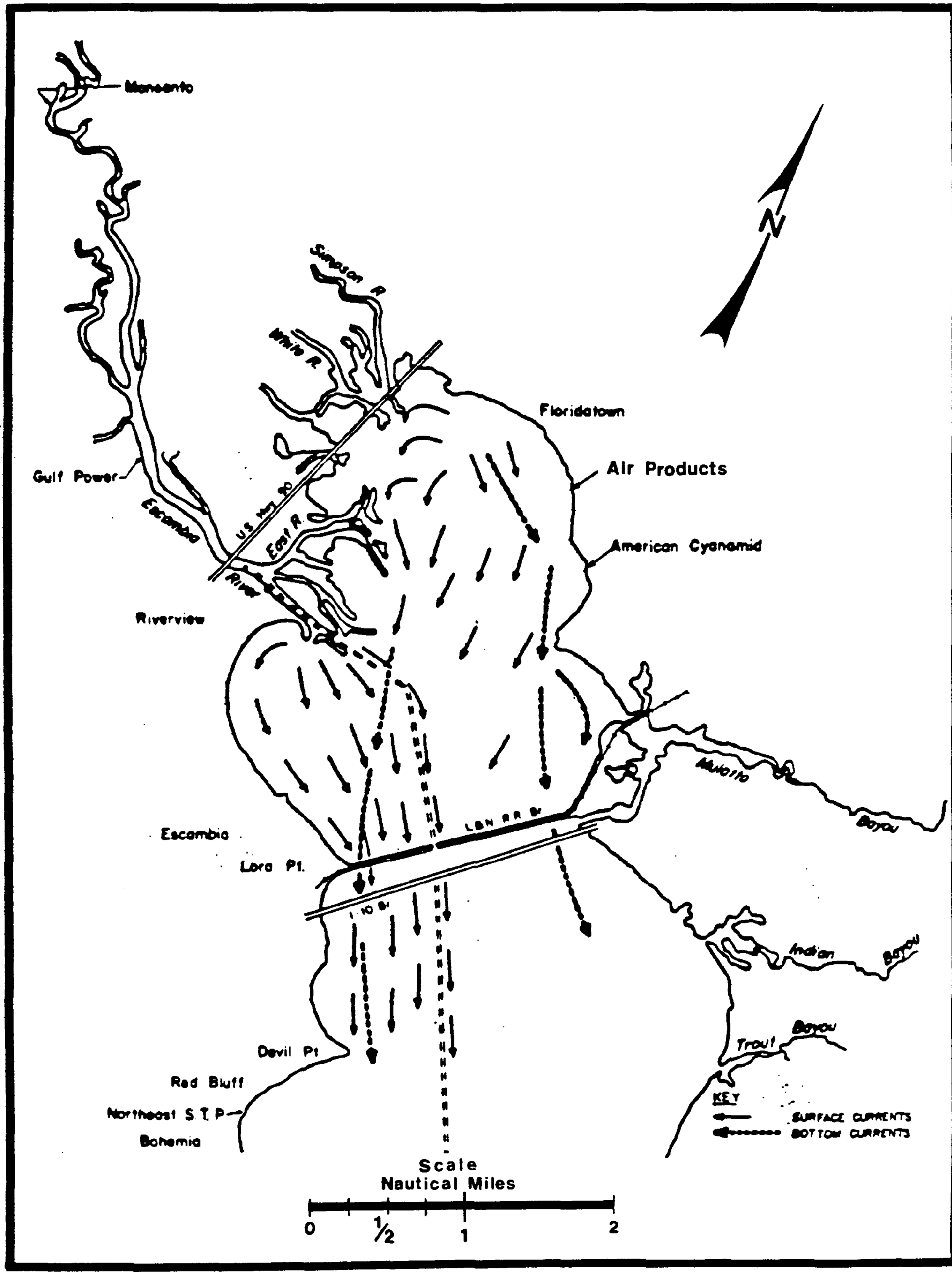


Figure 1.3 Ebb tide currents within Escambia Bay.

of Pensacola Bay can be expected to be flushed from the system within 20-30 days." However, the effects that strong meterological perturbations have on the flushing of the bay should also be taken into consideration. These factors are generally more significant in estuarine water exchange than any routine processes or average conditions.

d. Uplands

Barnett and Gunter (1985) reported that six general soil types are present in the regions immediately adjacent to the estuary (Florida Department of Administration, 1975) (Figure 1.4):

1) The Lakeland - Eustis association are upland soils not affected by groundwater. They are characterized by sandy and loamy, sandy soils more than 40 inches in depth covering finer textured subsoils. These soils have a low moisture capacity and rapid permeability. The association is located along the western shore of Escambia Bay and has only slight limitations for septic tank drainfields and severe limitations for sewage evaporation percolation ponds.

2) The Lakeland - Troup association is characterized by nearly level to steep, excessively drained soils which are sandy throughout and well-drained soils with very thick sandy layers over a loamy subsoil. This association is found in the upland areas of the eastern shore of East Bay and north of the Yellow River. Slight limitations for septic tank drainfields but limitations for sewage evaporation-percolation ponds are severe.

3) The Lakeland - Paola association is characterized by level to steep, excessively drained soils that are sandy throughout. This association is found on the southern shore of East Bay and on the extreme western end of the Gulf Breeze Peninsula. It has slight limitations for septic tank drainfields and severe limitations for evaporation-percolation ponds.

4) The Chipley - Scranton association is nearly level to gently sloping, moderately well to somewhat poorly drained sandy soils. This association is located along the Gulf Breeze Peninsula and throughout the upland portions of the Garcon Peninsula. Limitations are moderate for septic tank drainfields and severe for evaporation-percolation ponds.

5) The Doravan - Pamlico association soils are nearly level very, poorly drained organic soils that are underlain by sand. This association is found throughout the floodplain of the Yellow River and along the eastern shore of East Bay. Septic tank restrictions and evaporation-percolation ponds are moderate.

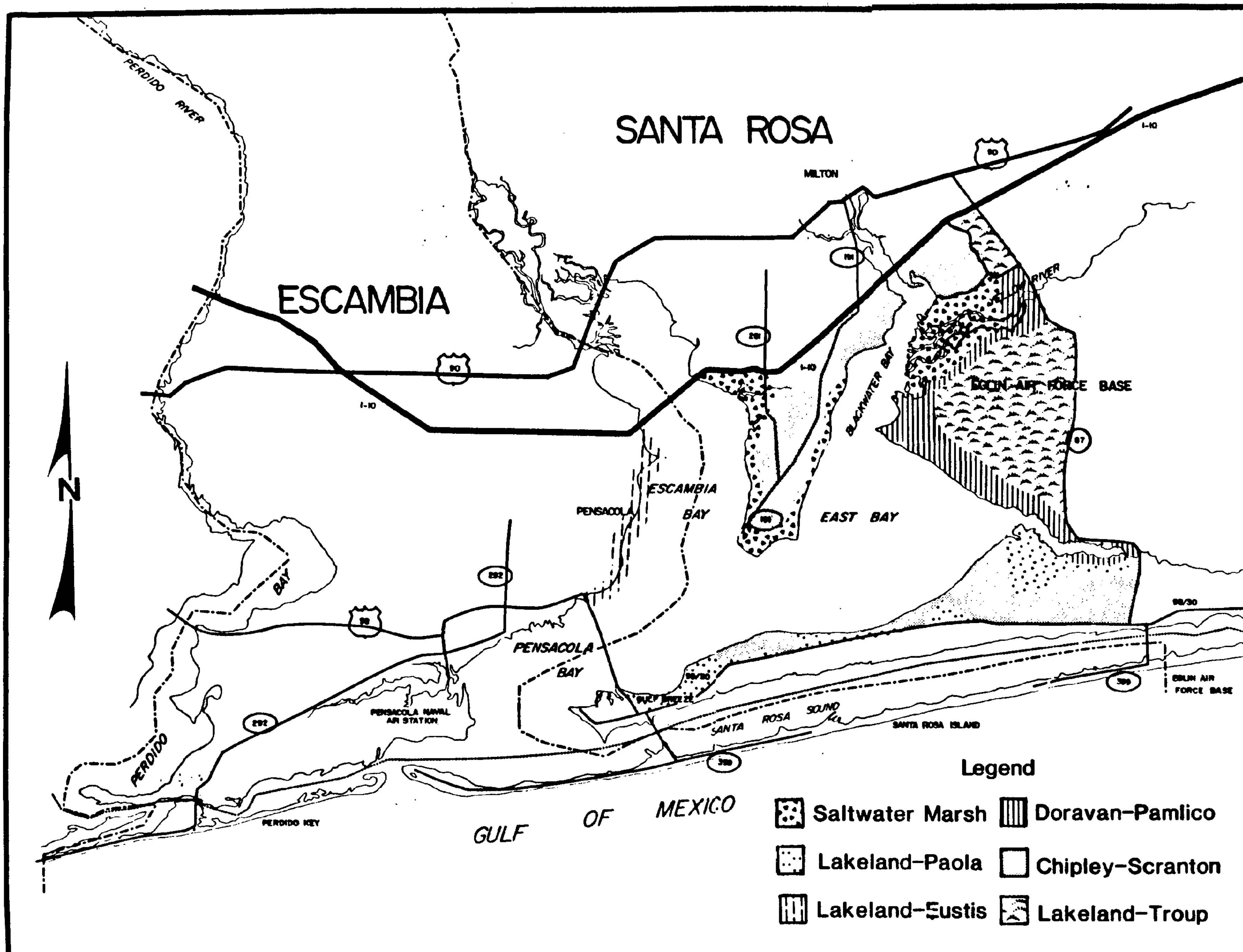


Figure 1.4 Soil types surrounding the Pensacola system

6) A salt marsh association is characterized by level, very poorly drained soils subject to frequent flooding by tidal water. This association is located along the entire shoreline of the Garcon Peninsula and in the mouths of area rivers. Severe limitations exist for septic tanks and evaporation-percolation ponds in these regions.

1.3 Documented Problems

Six major categories of degradations were delineated in the Pensacola Bay system:

1) aquatic vegetation declines - submerged (i.e., seagrasses and brackish/freshwater vegetation) and emergent macrophytes (i.e., saltmarsh grasses) are focused upon;

2) shellfish/finfish declines - catch declines;

3) water quality degradations - nutrient loading, DO (dissolved oxygen) declines, and toxic inputs, including hydrodynamic alterations;

4) estuarine sediment contamination - trace metals, nutrients, and benthic community changes;

5) bayou-specific problems - low flushing capabilities and seasonal anoxic conditions, and;

6) estuarine erosion/shoreline alterations - especially the north shore of Santa Rosa Island.

Each of these categories are discussed in detail below. These, in turn, were correlated to past and current land management practices in the areas that surround the bay system.

1.4 Aquatic Vegetation Declines

a. Submerged Macrophytes

Introduction.
This category includes the true seagrasses (i.e., submerged halophytes that require saltwater to survive) and fresh- and brackish-water species. The Pensacola Bay system contains three species of seagrasses: *Thalassia testudinum* (turtle grass), *Syringodium filiforme* (manatee grass), and *Halodule wrightii* (shoal grass). There are two common brackish-water species encountered: *Vallisneria americana* (tape grass) and *Ruppia maritima* (widgeon grass).

Submerged macrophytes have a number of important functions in estuarine and marine ecosystems (Zieman, 1982). These include:

a) providing high organic productivity with a rapid growth rate;

b) acting as a direct food resource for some organisms but more importantly supplying a bulk of the detritus for the entire estuary;

c) providing habitat surfaces (the leaves offer a substrate for epiphytic organisms that are themselves important prey for many organisms);

d) playing an important role in estuarine geochemical cycling;

e) reducing current velocities and promoting the sedimentation of organic and inorganic particles;

f) binding the sediments with roots and rhizomes and hindering the erosion of the sediment surface, and;

g) acting as nursery areas for important commercial and recreational fish and invertebrate species.

Overall, the density and diversity of organisms are significantly higher within vegetated patches than in unvegetated sediments (Zieman, 1982). Faunal densities may be three times greater in the vegetated areas than barren sand flats. Olinger et al. (1975) reported that the total number of species present could be reduced by one-half if Vallisneria was lost from Escambia Bay and over 60% of the species could be lost if Halodule were lost from East Bay. The latter condition presently exists, however no studies have been conducted to examine the decline in species diversity. Together with seagrass disappearance there is a simultaneous disappearance of all the animals that are epiphytic (i.e., grow on the blades) on the grasses and of organisms that feed upon these forms.

Livingston (Environmental Analysts of Florida, Inc., 1979a) reported on fish associated with grassbeds in Santa Rosa Sound. The dominants included the pigfish Orthopristis chrysoptera, pinfish Lagodon rhomboides, lizardfish Synodus foetens, and others. Commercial species such as flounder, blue crabs, and penaeid shrimp juveniles also use the grassbeds (Hoese and Jones, 1963).

Evidence exists from other estuaries (e.g., Chesapeake Bay (EPA, 1982)) that the decline of seagrasses can be attributed to water quality conditions and dredge/fill activities. Long-term trends indicate increasing amounts of suspended sediments, detritus, and phytoplankton in the Pensacola system which reduce downwelling light. Despite a lot of water quality data, complete analyses have not been done to attempt to document long-term trends in all these factors as they relate to downwelling light in the Pensacola Bay system. Physiological studies (e.g., Williams and McRoy, 1982) have shown that light-dependent productivity peaks at approximately 65 - 70% SI (surface irradiance) and that the half-saturation constant (half maximum photosynthesis) ranges around 50% SI. Management of light levels to support healthy seagrasses should target this half-saturation value, not a compensation value. There are serious implications for the seagrasses in terms of reproductive success and growth if only minimum light levels are available.

The Pensacola system was the focus of a historical submerged macrophyte study and inventory by Rogers and Bisterfield (1975). They reported that the entire system experienced an overall recession and disappearance of grassbeds from 1949 - 1974.

Recent LANDSAT surveys indicate present coverage is approximately the same as in 1974 indicating little if any recovery has taken place (Haddad, personal communication). Santa Rosa Sound seagrasses were investigated by Winter (1978) with damage noted in several beds. The EPA conducted an overflight assessment of seagrass distributions primarily in the Santa Rosa Sound in October, 1980, as part of a survey along the Panhandle (Williams, 1981).

Individual Bay Discussion.

See Figure 1.5 (pp. 15-18) for an historical perspective on submerged macrophyte distributions.

(a) Escambia Bay - The Escambia River delta primarily contains *Vallisneria americana*. The region appeared the least degraded of the entire Bay in the mid 1970's (Rogers and Bisterfield, 1975). *Vallisneria* was reported to be even be more abundant (as of 1974) than it had been early in the records.

Along the western shore, *Vallisneria americana* was present in the McKay Bay area north of Laura Point. In 1974, only one small bed approximately 1 mi north of the point existed in four discontinuous patches. Historically, the area has undergone recession.

The northeastern corner of the bay (i.e., Floridatown shoreline) had extensive submerged macrophytes (with *Vallisneria* dominant) in 1949. The greatest extent was from Basshole Cove south to Fisherman's Point and small patches near Mulatto Bayou. The next record in 1963 indicated that the grasses were gone. Coincidently, industries started operations on the bay during this time period: along the northeast corner of the bay Air Products began in 1955 and American Cyanamid began in 1958; up the Escambia River Monsanto began in December 1953, and; further up the watershed Container Corporation in Brewton, Alabama began in 1957.

In the bay below the I-10 bridge, the seagrasses were probably comprised of *Halodule wrightii* due to the higher salinities present (Rogers and Bisterfield, 1975). Sparse growth was recorded in 1965 along the southwest Magnolia Bluff area. This extended for a length of 1.6 km and a width of 0.64 km (Van Breedveld, 1966). A dense bed existed north of Magnolia Bluff where the Northeast Pensacola STP outfall pipe was laid. *Halodule* grew best along the lower southeast shore above Hernandez Point. It extended in discontinuous areas from the point up to I-10. In 1974, no grasses were present. A gradual loss of seagrass was noted over a 17-yr period from 1949 - 1966. By 1970, all of the seagrass had disappeared. Examination in 1973 - 1974 revealed no vegetation along the shoreline (Rogers and Bisterfield, 1975).

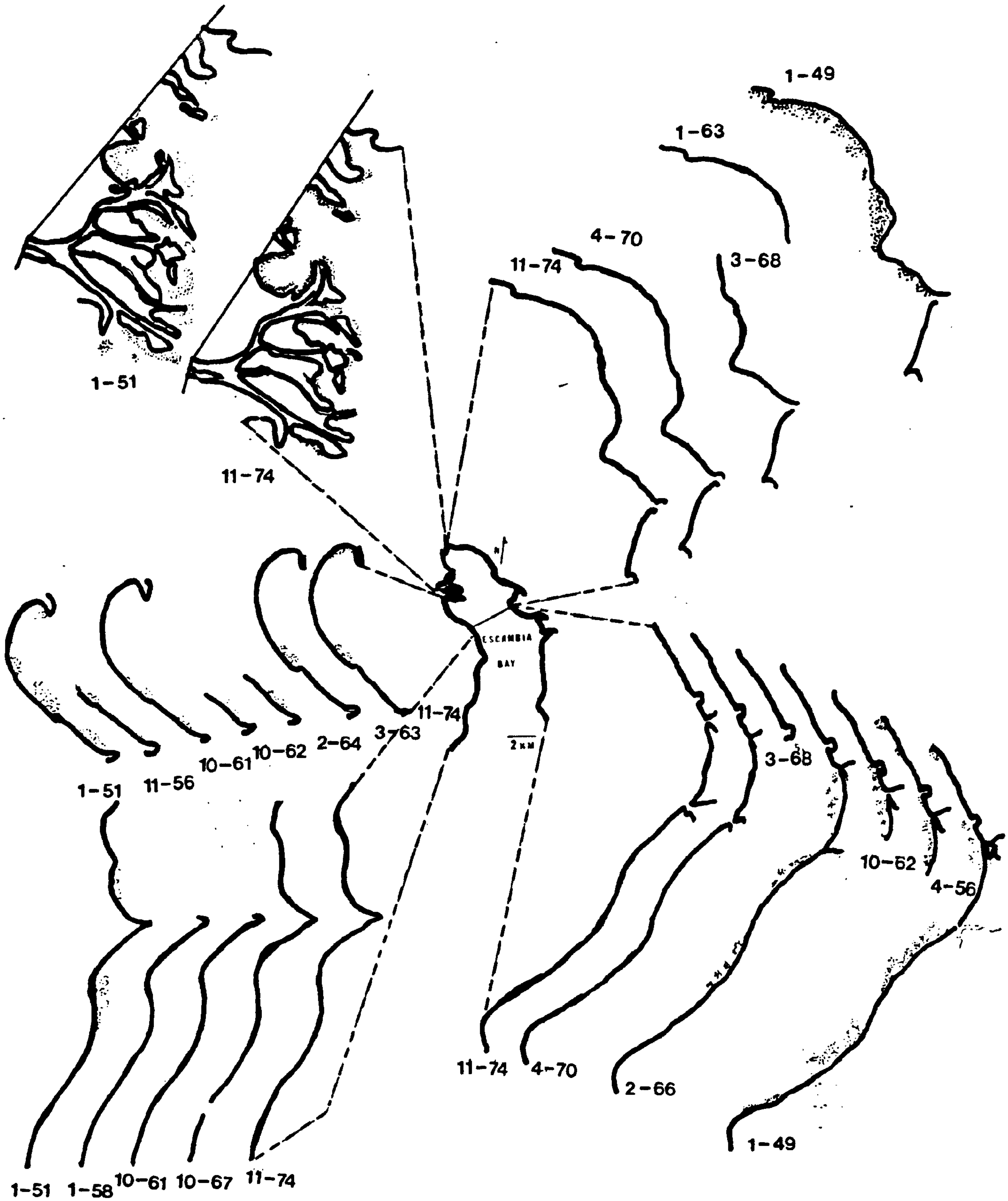
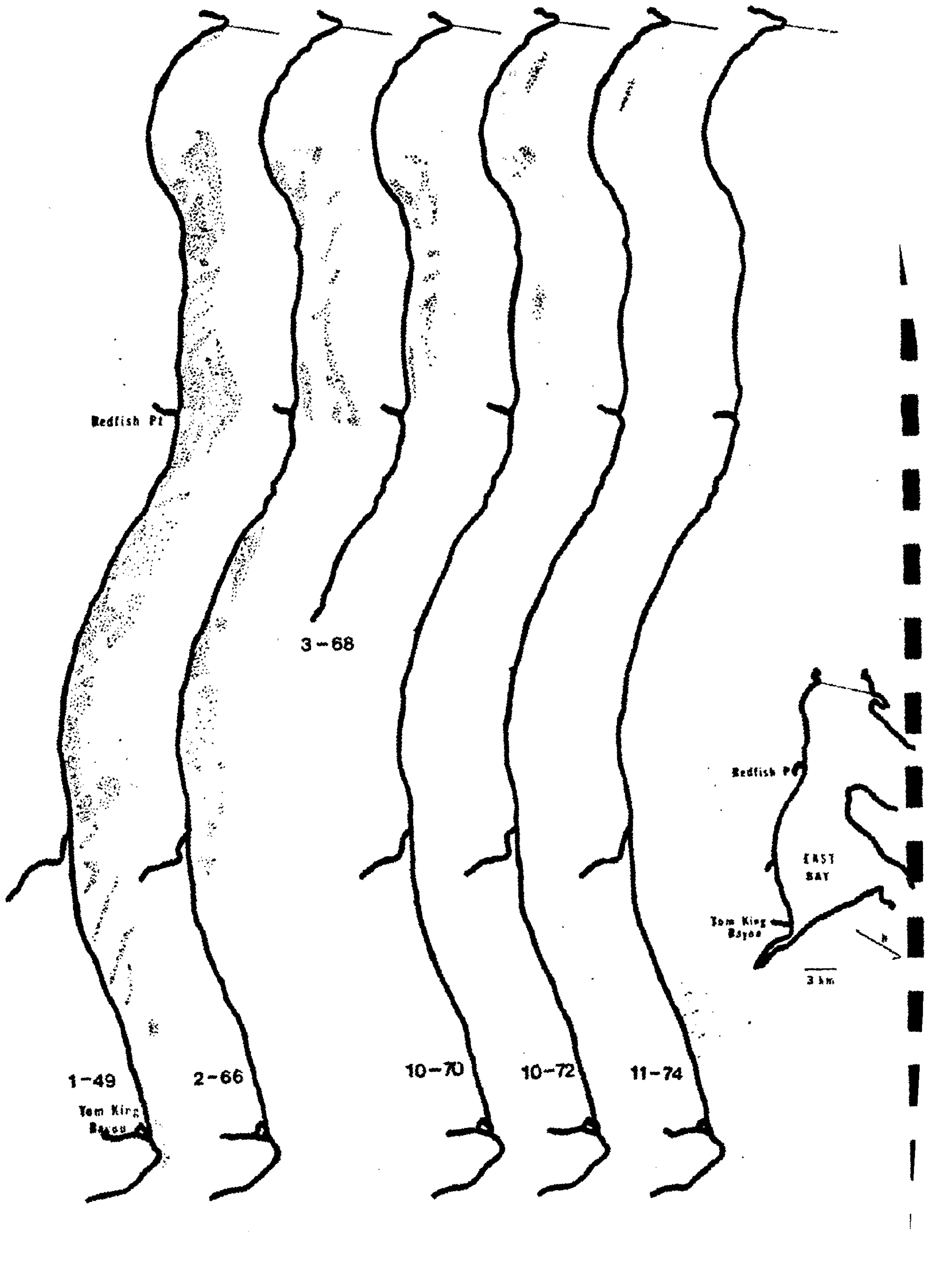
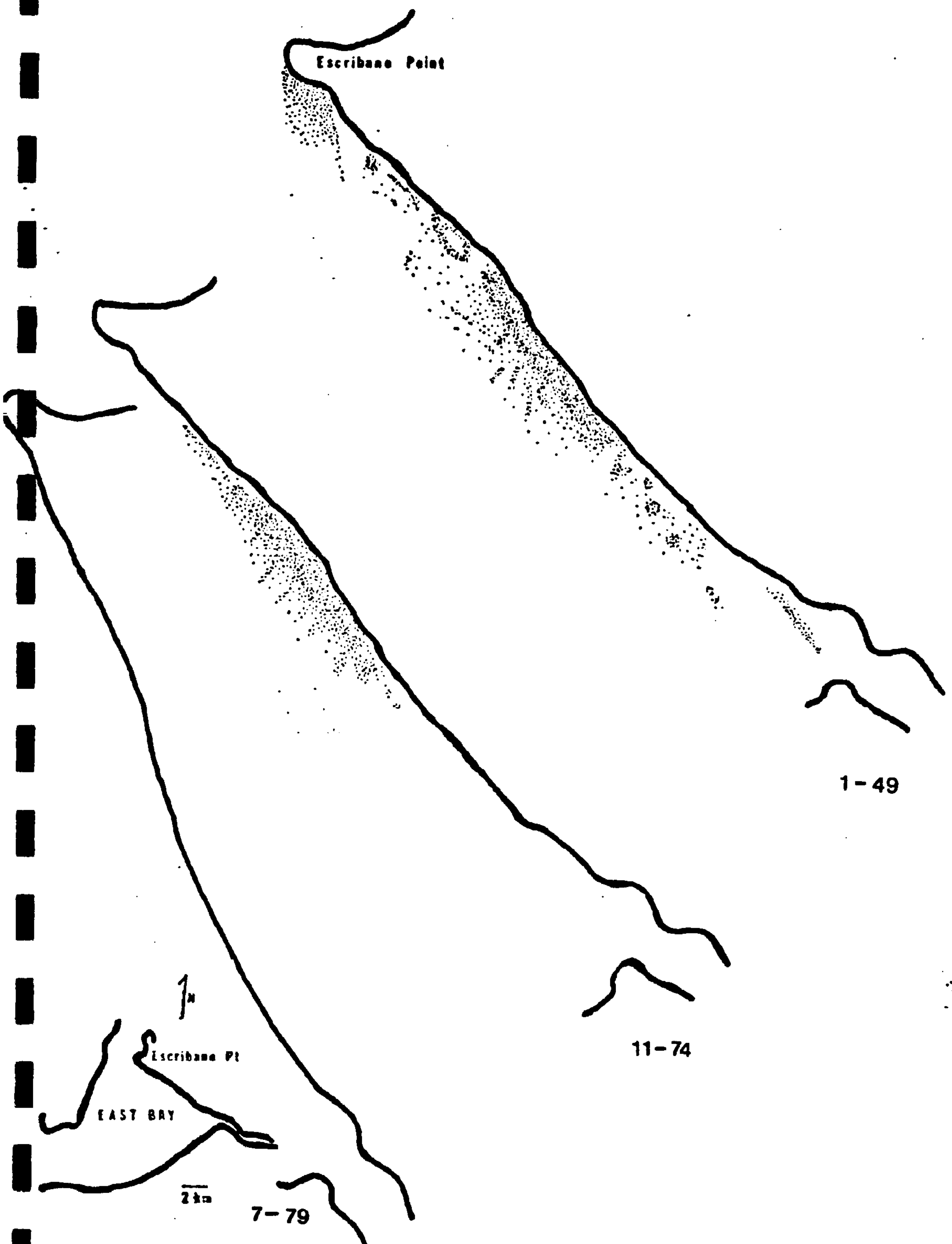


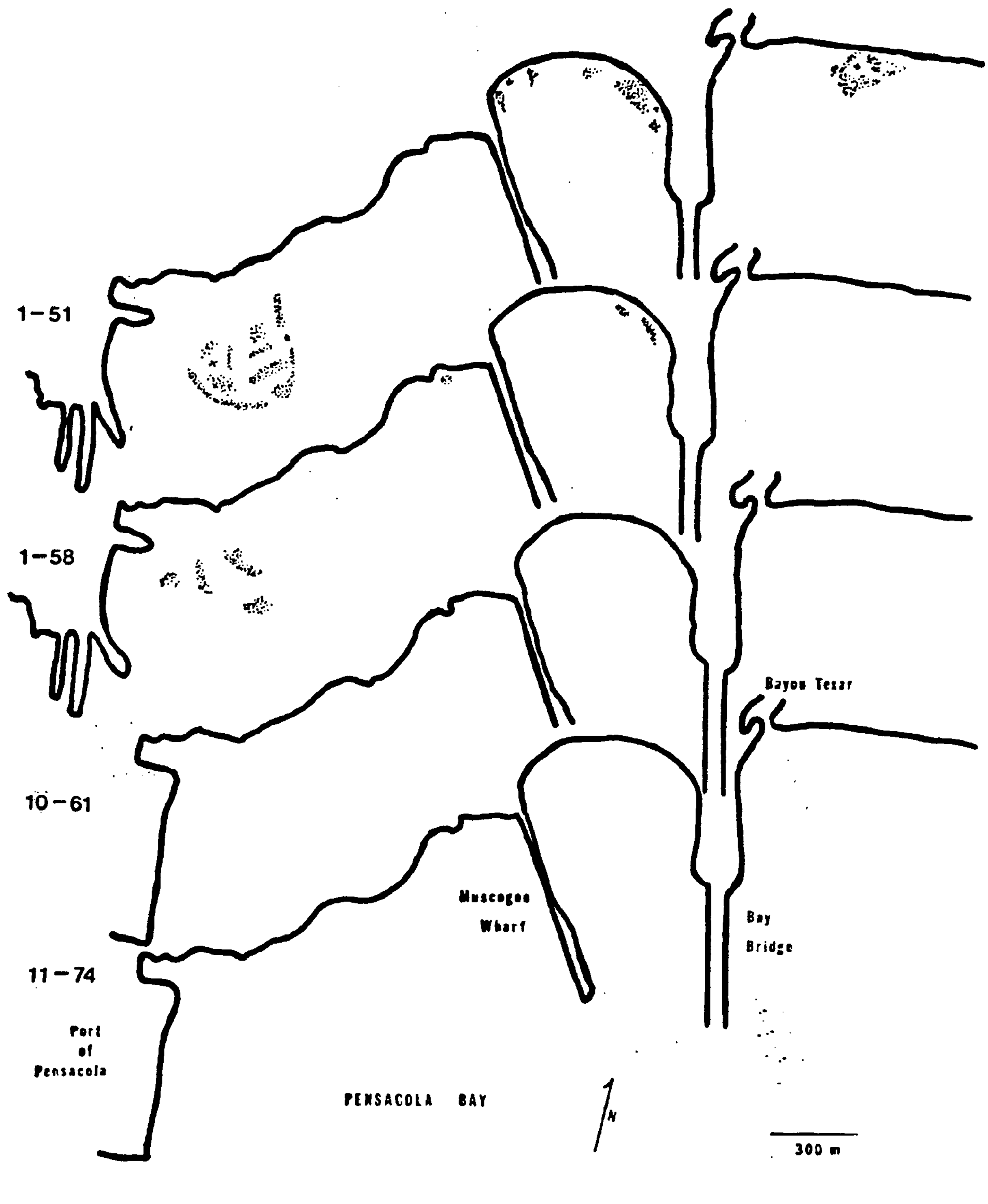
Figure 1.5 Submerged macrophyte distributions (1950-1979).



Redfish Pt
3-68
1-49
2-66
10-70
10-72
11-74
Tom King Bayou
Redfish Pt
EAST BAY
Tom King Bayou
3 km



Escribano Point
1-49
11-74
N
Escribano Pt
EAST BAY
2 km
7-79


1-51
1-58
10-61
11-74
Port
of
Pensacola
PENSACOLA BAY
Muscogee
Wharf
Bay
Bridge
Bayou Texar
N
300 m

The Northwest Office of FL DER reported that revegetation by Halodule wrightii had been observed in eastern Escambia Bay near Indian Bayou (Interdepartmental Memo, April, 1985). So it appears that at least in some portions of the system seagrass may be beginning to recover.

In conclusion, Escambia Bay had extensive seagrass beds along all shores in 1949 except for sparsely vegetated areas along the southwest shore. By 1974, all were gone except stands of Vallisneria americana along the upper western shore where there is a significant freshwater influence from the Escambia River.

(b) Pensacola and East Bay - Several small grassbeds near the north side of the Pensacola Bay Bridge were first recorded in 1951 in addition to other beds adjacent to the Bay Bridge and Bayou Texar. In 1960, the enlargement of the Port of Pensacola (Phase I) involved extensive dredging and filling. Additional work was done in 1967. All the nearby grass beds were gone by October, 1961, and have not reappeared.

The south shore of Pensacola Bay west of the Bay Bridge had not been historically mapped. East of the bridge a nearly continuous 22.5 km grassbed extended to Tom King Bayou. Ground truthing in 1966 (Van Breedveld, 1966) indicated Thalassia testudinum was the dominant species beginning in Butcherpen Cove and extending eastward 1 mile. At some point east toward Tom King Bayou, Halodule probably replaced Thalassia as the dominant species (Rogers and Bisterfield, 1975). Salinity at a nearby station (during 1974) ranged from 4-20 ppt. The salinity values ranged too low for Thalassia to exist. From 1949 - 1966, the seagrass coverage decreased by approximately one-half. From 1966 - 1974 (in 2-year intervals), the record showed an accelerated loss. Between 1966 and 1968 seagrass density decreased by over one-half. It appears that the loss may have been primarily Halodule and that Thalassia was reduced only slightly. However, over the next two intervals, Thalassia continued to diminish until 1974 when none was present.

Two records (January, 1949, and November, 1974) existed for the northeast area of East Bay (Olinger et al., 1975). They revealed a decline in lateral extension of the bed, however the width of the central area appeared to have remained relatively constant. Two years later this bed had also disappeared (J.D. Brown, personal communication). A study by Environmental Analysts of Florida, Inc. in June, 1979, also reported the absence of seagrass between Escribano and Miller Points.

(c) Blackwater Bay - Blackwater Bay has a lower salinity than the other bays, therefore the grassbeds are comprised primarily of Vallisneria americana with some Ruppia maritima interspersed. Historical records show the beds occupied the same areas in 1974 as in the early 1950's (Rogers and Bisterfield, 1975). A DER memo (1983) noted substantial beds of tape grass Vallisneria americana and widgeon grass Ruppia maritima were found in the Yellow River delta area. The shoal area between the Yellow and Broad River was vegetated by Vallisneria covered with heavy epiphytic growth indicating over nutrification. Areas closer to the bay were apparently buffered from over nutrification by better water quality in the Weaver River as evidenced by the lack of epiphytes growing on Vallisneria and Ruppia.

(d) Santa Rosa Sound - Three species of seagrasses are present in the Sound: Halodule wrightii, Thalassia testudinum, and Syringodium filiforme. Historical records extend only back into the 1970's. Viable seagrass beds are generally found between the 1 and 3 m depths on sandy substrates and more frequently in areas lacking development on the adjacent shoreline (Winter, 1978).

Grassbeds are present in a nearly continuous bed along the northern shore of the Sound. The most concentrated and extensive beds along the southern shore of the Sound were located in the vicinity of Range Point (approximately 32.6 acres). Beds (2 near Range Point) containing dead seagrass were noted at the 4 - 5 m depth range. Turbidity was postulated as the probable cause.

The most recent account of seagrass bed coverage in the Sound was published by Williams (1981). There were extensive, nearly continuous beds present along the north shore of the Sound.

(e) Summary - There has been a history of extensive submerged macrophyte loss in the entire Pensacola Bay system. At the present time, seagrasses (i.e., Thalassia and Halodule) are nearly absent from the system with the exception of Santa Rosa Sound and the Big Lagoon. Excluding these two areas, the only abundant, persistent species are Vallisneria americana and Ruppia maritima, essentially brackishwater species, that are doing well in Blackwater Bay, but which have diminished in upper Escambia Bay.

Factors Contributing to Macrophyte Decline.

Olinger et al. (1975) reported that in the Pensacola Bay system artificial factors - sewage and industrial waste discharges, dredging and filling, beachfront alterations, and changing watershed characteristics - appeared to have synergistically affected the entire system. Additionally, certain factors had increased the impacts of local effects. For example, the loss of vegetation around the Northeast STP was caused by laying the discharge pipe directly through a bed and later by sewage effluents. Along the southern shore of East Bay, bulkheads and groins likely caused changes in nearshore water movements and led to the erosion of the seagrass beds. Industrial discharges, "no doubt" (Olinger et al., 1975), caused the loss of vegetation in the northeast section of Escambia Bay because these effluents generally remain near the shore due to the hydrography of the region. Dredging and filling of the Port of Pensacola high caused turbidity that affected the vegetation, in addition to the actual physical removal of the grassbeds in some instances.

Winter (1978) noted that viable seagrass beds in Santa Rosa Sound were found more frequently in areas lacking housing on the adjacent shoreline. In addition, the beds that were located near developed shorelines were "immature" (i.e., in terms of species composition). She proposed that the water remained turbid in the study region from various projects preventing sufficient light penetration for seagrass growth. She listed the following as the primary sources of turbidity in the region: street and land runoff from areas surrounding the estuaries; agricultural runoff that included soil as well as fertilizer and provided a substantial contribution considering much of the eastern half of Alabama drains through Pensacola Bay; industrial wastes; municipal wastes; watershed runoff that has increased because forests in the Florida and Alabama watersheds have been cut, and; increased phytoplankton populations from the increased nutrients available from the above sources.

The turbidity explanation has some support based upon the viability noted in the deeper grassbeds off the north shore of Santa Rosa Island. Winter (1978) noted that beds in 12-15 ft of water were dead, especially in the regions just adjacent to shore areas that had extensive development. The same depth regions off undeveloped areas such as the National Seashore and Fort Pickens harbored live beds.

Some recent studies have calculated the euphotic depth for seagrasses, assuming that the plants can survive to a depth where 1% of surface irradiance (SI) is present. However, existing scientific literature indicates that seagrasses really need 10 - 50% SI to survive (Williams and McRoy, 1982; Rice et al., 1983). These intensities only occur in shallow water within the estuary. It would appear that seagrass beds are light-limited and that some substances in the water column have increased in recent years and are responsible for reducing the amount of light that historically supported seagrasses in deeper water. Therefore, light attenuation may have played a major role in the demise of Pensacola Bay seagrass beds. A number of substances including suspended sediment, detritus, tannins, and chlorophyll pigments in the phytoplankton can reduce downwelling light (i.e., the amount of sunlight that passes through the water column and is absorbed by plants or reflected by unvegetated bay bottoms).

In summary, the studies performed in the system have concluded that increased turbidity from several possible sources has contributed to the decline of grasses in the system. As the reports indicate, many factors have probably synergistically contributed to the general increased turbidity. Subsequently, it is probably impossible to attribute the condition to only one source.

Previous Recommendations.

Olinger et al. (1975) - The only area where seagrasses have remained relatively stable is in Santa Rosa Sound. This area should be considered as endangered and every effort should be made to preserve the integrity of these seagrass beds.

Winter (1978) - Turbidity will be an important problem in the future success of beds in Santa Rosa Sound. Any increase in turbidity will result in additional seagrass death and those covered by fill will also be destroyed. Regrowth of seagrasses in the developed area seems possible and since they stabilize sediments, seagrass could probably retard the curent rate of erosion along the shoreline.

b. Emergent Macrophytes and Tidal Areas

Introduction.

Intertidal salt marshes and other natural shoreline features such as intertidal mud flats perform critical functions in the overall estuarine ecosystem. They supply a large portion of the detritus and primary productivity to the immediate areas. They act as a nursery ground for many important commercial and recreational species. They also act as a filter and sediment trap for upland runoff and buffer immediate inshore lands from storm effects. Generally, reports on the distribution and areal coverage of salt marshes in the Pensacola system have been lacking.

Discussion.

In 1973, Hopkins reported that over 20% of the Pensacola Bay shoreline was comprised of salt marsh (14.4% in Escambia County and 31.2% in Santa Rosa County). More recently (1982), the USFWS published maps that depicted wetland distributions around the system. The steep mainland bluffs along the western shore of Escambia Bay do not support broad salt marshes; these are restricted to the shorelines of the Pensacola, Escambia, and East Bays (Stout, 1984). The principal component grasses in the marshes are black needlerush Juncus roemerianus and smooth cordgrass Spartina alterniflora. Hopkins (1973) espoused the need for urgent basic research in Juncus marshes to establish their role in the food chain of the Pensacola system.

A typical salt marsh in the Pensacola system was described by Green and Edmisten (1974). Generally, the outer (i.e., seaward-most) margin is comprised of *Spartina alterniflora* approximately 1 to 2 m high. These grasses are usually covered with salt water. The plant bases are the only portions entirely exposed during very low tides. Above approximately the mean low tide line, *Spartina* is replaced by *Juncus roemerianus* which makes up the majority of the remaining marsh system. Within the *Juncus* zone, there are openings (1 - 2 m^2, commonly called barrens) that are comprised of small vascular plants dominated by *Lilaeopsis chinensis*. In the late summer, two composites (i.e., a family of dicotyledonous herbs, shrubs, and trees) bloom in those areas: *Solidago mexicana* and *Pulchea camphorata*. Also within the *Juncus* zone patches of *Kosteletzkya virginica* grow. Beyond the *Juncus* zone is a somewhat higher and narrower zone of mixed grasses that include: *Pancium virgatum* (switch grass), *Distchilis spicata*, *Spartina patens*, and *Sporobolus virginicus*.

Along the northeast shores of Escambia Bay, freshwater and "transitional freshwater" species dominate. Common species include the giant reed *Phragmites communis*. Young and Donelan (DER Interdepartmental Memo, 1983) reported that it covered approximately 95% of sections of the shoreline along Escambia Bay from Floridatown to below Mulat Bayou. The freshwater bulrush *Scirpus americanus* (bulrush) grew bayward of *Phragmites*. *Spartina patens* (a transitional marine species) grew inshore of *Phragmites* in scattered areas.

Associated Fauna.

Salt marshes support a very diverse wildlife population. Racoon, fiddler crabs, shrimp, killifish, and mullet are abundant. In addition, extensive waterfowl and shorebirds such as pelicans, seagulls, terns, heron, and egrets are found throughout the area's salt marshes (Table 1.2).

Table 1.2. Partial list of commom waterfowl that winter in Pensacola Ba salt marshes.

Common Name	Scientific Name
Bufflehead	*Bucephala albeola*
American goldeneye	*Bucephala clangula*
Piping plover	*Charadrius melodus*
Old-squaw	*Clangular hyemalis*
Dunlin	*Erola alpina*
Harlequin duck	*Histrionicus histrionicus*
Bonaparte's duck	*Larus philadelphia*
White-winged scoter	*Melanitta deglandi*
Surf scoter	*Melanitta perspicillata*
Common scoter	*Oidemia niger*
Red phalarope	*Phalaropus fulicarius*

Sora	Porzana carolina
Greater yellowlegs	Totanus melanoleucus

The saltmarsh topminnow is a species of special concern in Florida and is only found in Escambia, East, and Blackwater Bays in the entire State. It has been recorded only a few times and these areas may represent the easternmost occurrence of the species in North America.

1.5 Shellfish/Finfish Declines

a. Shellfish

Oysters.

The most recent survey of the oyster populations in the Pensacola Bay system was conducted by the Department of Natural Resources, Shellfish Environmental Assessment Section from April, 1980, to January, 1985 (Barnett and Gunter, 1985). The primary oyster species harvested in the Pensacola system is the eastern oyster (Crassostrea virginica). Oysters are filter feeders and tend to concentrate (i.e., bioaccumulate) pollutants that are present in the water column, such as heavy metals, petroleum hydrocarbons, pesticides, and fecal coliform (i.e., pathogens) and are therefore sensitive to degradations in water quality.

The Pensacola Bay system can be a very productive oyster harvest area (Barnett and Gunter, 1985) (Table 1.3). The estuary, however, has experienced a history of massive oyster kills that have seriously hurt the oyster industry. In September, 1971, over 90% of the commercially harvestable oysters in Escambia Bay were found to be dead (Little and Quick, 1976). The mortality was caused by the fungus Perkinsus marina (Mackdin, Owen, and Collier) (also called "dermo disease" and previously named Labyrinthomyxa marina). Because of degraded water quality conditions in the system, the susceptibility of the oysters to the disease may have been increased (Quick, 1971; Walsh, 1972). Over $300,000 in losses were projected in potential oyster harvests over the following three years.

Table 1.3. Oysters landed (lbs. of meat) in Escambia and Santa Rosa Counties.

	Escambia County	Santa Rosa County
1965	22,554	12,207
1966	34,467	44,049
1967	62,172	16,229
1968	16,038	34,166
1969	71,372	49,335
1970	126,520	126,035
1971	50,380	62,370
1972	9,253	23,688
1973	7,287	25,695
1974	36,536	27,862
1975	5,739	13,699

1976	0	7,443
1977	0	900
1978	12,198	656
1979	0	0
1980	0	0
1981	587	0
1982	35,093	12,000
1983	78,000	41,000

Since the original survey by the Florida State Board of Health in 1951, the waters of the Pensacola Bay system that lie within Escambia County have not been open for shellfishing. One resurvey was performed by the State of Florida Department of Health and Rehabilitative Services in 1970. The report concluded that "the presently Approved areas are valid with the possible exception of extreme northern portions of the Escambia Bay area and the extreme eastern restricted end of East Bay" and recommended the closure of the area north of the I-10 bridge in Escambia Bay and east of Miller Point in East Bay. The legal description for the originally approved area was: "That portion of Escambia Bay south of Interstate 10 bridge and east of a line along the navigational channel from the I-10 bridge southwesterly to Flashing Light Marker Number 2 (Lat. 30° 28' 00", Long. 87° 06' 26"), thence southerly to Butherpen Point; and all of East Bay south of an east-west line through Escribano Point and west of the mouth of East River (Miller Point)" (Tisdale, 1972).

Presently the "Approved" shellfish harvesting area is located entirely within the waters of Santa Rosa County. The 1985 DNR report recommended revising the shellfish harvesting area to the one shown in Figure 1.6 (Barnett and Gunter, 1985).

The shellfish growing waters of Escambia Bay are buffered from direct stormwater runoff from the City of Pensacola because the high bluff on the west shore of Escambia Bay prevents most urban runoff from entering directly into the bay. Primarily, runoff enters the system through Bayou Texar. Boat traffic may contribute various metals including copper and lead, petroleum hydrocarbons from fueling and usage, as well as occasional discharges of raw or partially treated sewage. Commercial and recreational boat usage is high in the summer. There is a high amount of boat traffic through Approved waters because the area north of the I-10 bridge is heavily industrialized.

Agricultural activities are limited within the immediate region of the bay, but land use within the watershed of the Escambia River is approximately 16% agricultural (NWFWMD, 1977). Cropland and pastureland are the predominant agricultural land uses and are concentrated in the middle and upper portions of the

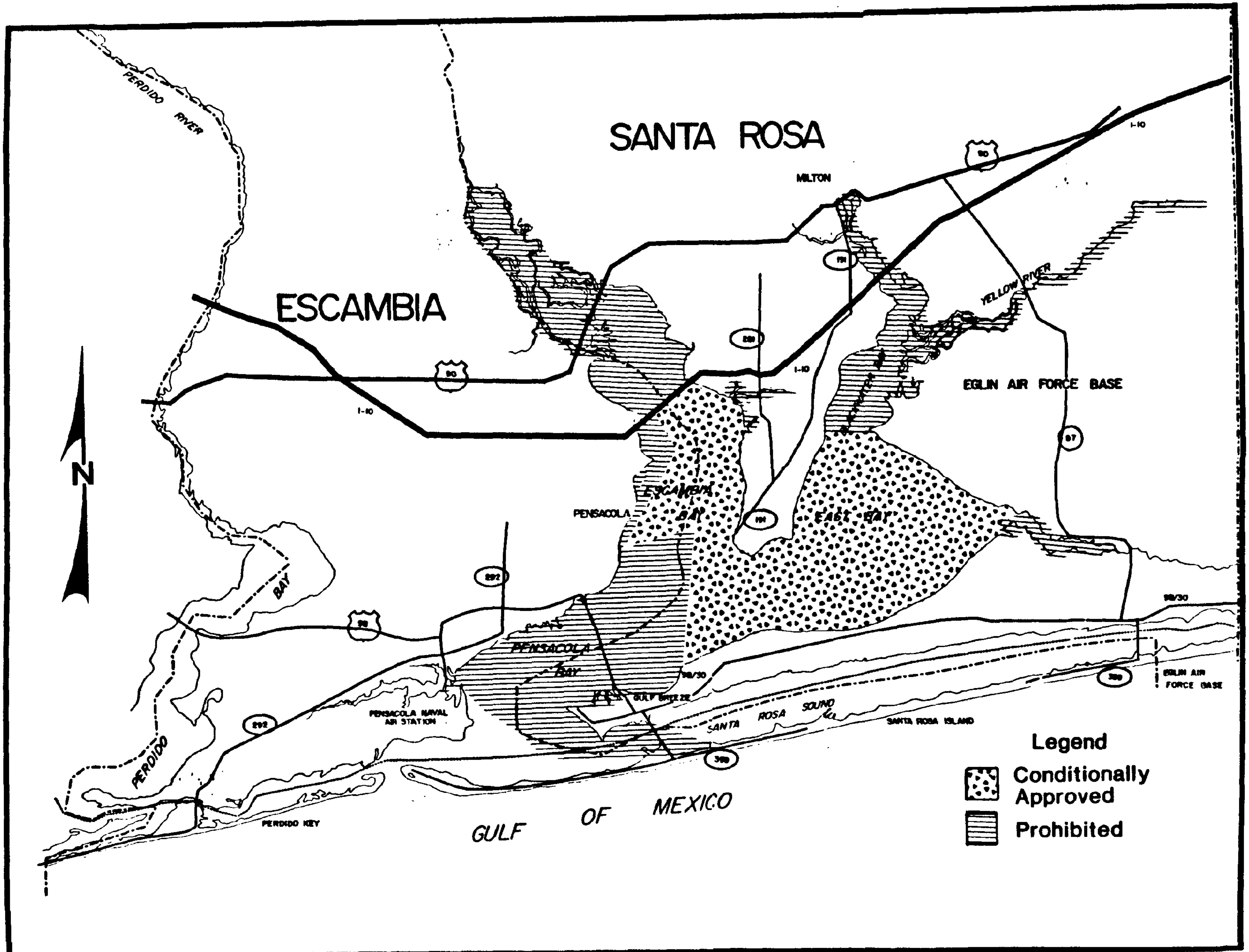


Figure 1.6 Shellfish harvesting areas within study area (Barnett and Gunter, 1985).

basin. Olinger *et al.* (1975) calculated average annual quantities of stormwater runoff (expressed in unit values kg/day/km^2) to be 7.7 BOD, 3.7 Total Nitrogen, and 0.6 Total Phosphorus into the Pensacola Bay system.

Barnett and Gunter (1985) reported that there were significant associations between rainfall events and fecal coliform levels and between the Escambia River stage and fecal coliform levels at most stations examined. Mathematical modeling showed that 2.1 in of rainfall over a 72-hour period and/or 14.0 ft of Escambia River stage resulted in predicted fecal coliform densities equal to 14.0 MPN (most probable number)/100 ml (the upper acceptable coliform limit for human consumption). The findings indicated that portions of the system previously designated Approved met standards for Conditionally Approved harvesting areas after significant rainfall events. In addition, 3,053 acres of Prohibited waters of western Escambia Bay also met standards for Conditionally Approved waters when the heavy rainfall events were deleted from analyses.

The report defined a new Conditionally Approved area with the following stipulations: 1) the region (as outlined) will be closed to shellfishing when local rainfall recorded at the Pensacola Regional Airport for any 72-hour period exceeds 2.1 in and/or an Escambia River stage greater than 14.0 ft is recorded at Century, FL, and 2) the area will be reopened to harvesting when fecal coliform densities meet the Interstate Shellfish Sanitation Program (ISSP) standards and sufficient depuration has taken place.

It is important to note that the county of landing does not necessarily reflect the county in which the catch was made. In fact, this is most apparent in the Escambia County data because it has not had Approved harvesting areas since 1951. However, the data do show fluctuations in oyster abundances within the system as whole through time.

Scallops.

The bay scallop (*Argopecten irradians*) is generally abundant among seagrass beds in the coastal waters of the Florida Panhandle. Hopkins (1973) reported that scallops were seasonally abundant in Santa Rosa Sound. Data on commercial harvests since 1965 reveal peaks in abundance in 1968 - 1969 but a virtually nonexistent commercial fishery since that time. Their declines can be attributed most likely to the demise of the seagrass beds. Scallops have planktonic larvae that attach to *Thalassia* blades in the winter. Without that substrate present, populations naturally decline. Seagrass may also provide scallops with protection from visual predators.

Shrimp.

Three shrimp species have been reported from the Pensacola system (in order of abundance): brown shrimp (Penaeus aztecus), white shrimp (P. setiferous), and pink shrimp (P. duorarum). The brown and white shrimp are the dominant species, comprising approximately 80% of the shrimp fauna.

The penaeid shrimp fishery in Escambia Bay declined from a high of 62,000 lbs (heads-off wt) in 1968 to its eventual collapse in 1972 when no shrimp were harvested from the bay (Olinger et al., 1975). Commercial shrimp landings in Pensacola Bay declined from over 902,000 lbs in 1968 to 17,000 lbs in 1971 (USNMFS, 1964 - 1973).

The disappearance of the shrimp fishery coincided with the initial discovery in 1969 of high concentrations of a PCB (Polychlorinated Biphenyl) (trade name Aroclor 1254). The synergistic effect of an artificial and a natural stressor was postulated to cause the mortality. PCB stress in brown shrimp (Penaeus aztecus) and the additional stress of low-salinity water produced death (Nimmo and Bahner, 1974). PCBs probably were not the sole cause of death.

There has been a recent recovery of the shrimping industry in the system that has been linked to the general improvements made in water quality (various DER memos).

The overall decline in the shrimping industry may be linked with the demise of the seagrass beds. Tampa Bay experienced marked declines in bait shrimp landings during the time period of seagrass loss (Tampa Bay Management Study Commission, 1985).

b. Finfish

The most abundant species in the system are: the bay anchovy (Anchoa mitchilli), Gulf menhaden (Brevoortia patronus), spot (Leiostomus xanthurus), Atlantic croaker (Micropogonias undulatus), striped anchovy (Anchoa hepsetus), sand seatrout (Cynoscion arenarius), tidewater silverside (Menidia beryllina), and the Atlantic bumper (Chloroscombrus chrysurus) (Cooley, 1978).

In February, postlarval and juvenile Gulf menhaden and resident bay anchovy dominate the catch. In June, juvenile spot and Atlantic croaker are the most abundant fish in the system. Gulf menhaden are dominant in the bayou and delta tributary areas from February through June. Juvenile menhaden are common in low salinity waters (0.0 - 0.5 ppt). The primary migration of offshore larval fishes from their spawning grounds in the Gulf of Mexico to Escambia Bay generally begins in November with the largest influx occurring from January to March (Olinger et al., 1975).

Fish kills have occurred in the bays, bayous, and rivers in the system since the late 1950's and reached their peak in the late 1960's and early 1970's (e.g., Hopkins, 1973). In a 5-year period from 1970 - 1974, 166 individual kills were recorded mainly from estuarine waters. Of this total, 81 (49%) occurred in the Escambia Bay subsystem, 15 (9%) in the East Bay subsystem, and 70 (42%) in the Pensacola Bay subsystem (Olinger et al., 1975). Since 1974, the number of fish kills has declined markedly.

Typically, fish kills have taken place in the eutrophic bayous. From 1970 - 1974, more than half of the fish kills occurred during the summer months and nearly two-thirds of these occurred from July to September. Pollution-caused fish kills have been attributed to excessive levels of nutrients, toxic metals, sewage, pesticides, and other industrial by-products. Eutrophication and subsequent low DO levels have been implicated in other kills. Low DO levels were the probable cause of mortality particularly among menhaden. Other kills have been attributed to the isolated or synergistic effects of industrial chemicals, pesticides, and other toxic substances (Olinger et al., 1975). Fish kills in Bayou Chico had been linked to the presence of phenols, oils, heavy metals, and resins (Glassen, 1977). Kills in Bayou Texar were possibly caused by domestic sewage overflow and runoff from lawns and shopping centers.

A chronic fish (primarily menhaden) kill in Escambia Bay in 1972 was blamed on a nonhemolytic streptococcus infection (Plumb et al., 1974). Environmental stresses may have lowered the resistance of the fish to the disease. Most kills were multispecies kills, however, menhaden as often the dominant fish species affected

There was a gradual reduction in the frequency as well as the magnitude of kills in the Pensacola system in the early 1970's (Table 1.4). This reduction has followed a general trend of improved water quality, especially in the DO and nutrient levels. Fish kills have declined to nearly zero in more recent years. Some of the ones that have been noted have come as the result of isolated incidents such as railroad derailments that have dumped diesel fuel or other toxic material into the water. However, during the late summer of 1986, two large fish kills were noted: one in Bayou Chico and one in the northeast corner of Escambia Bay.

Table 1.4. Fish kills within the Pensacola Bay system from 1970-1974 (after Olinger et al., 1975).

	Escambia Bay	East Bay	Pensacola Bay	Total
1970	35	0	21	56
1971	29	0	13	42
1972	5	13	17	35
1973	7	0	12	19
1974	5	2	7	14

The two kills occurred nearly simultaneously and persisted for several months. The kills began in the latter portion of July and continued throughout most of September. DER staff in Pensacola estimated the kill was greater than one million individuals in Escambia Bay. Affected species included nearly all types such as menhaden, pinfish, spot, mullet, striped mullet, croaker, sheepshead, and eel. Apparently, the proportion of game fish to commercial species declined with time. In September, the kill was comprised mainly of menhaden. The kill in Escambia Bay was attributed to two main factors: (1) low rainfall amounts which resulted in very low flows in the Escambia River and (2) nutrient inputs from nearby industries. The low flow for the year (through September 1986) occurred on July 7 at 900 cfs (cubic feet per second).

The kill reported in Bayou Chico was attributed to different albeit similar causes. The majority of industrial discharges have been removed from the water body however the sediments retain a large amount of nutrients and toxic material. Nutrients do enter the bayou from urban runoff and one domestic wastewater discharger. Under low flow conditions, these inputs are sufficient to cause significant reductions in oxygen from the water column. DER staff in Pensacola reported that as of early September 1986, over 68 tons of dead fish had been collected from the bayou.

Livingston (1977) noted in a study of fish kills in Mulatto Bayou that without the detailed diurnal and seasonal data that he collected from an intensive sampling schedule, the causative factors in the sequence of events would have remained unclear. The fish kills were part of a timed sequence of interrelated events that showed considerable variation over short and long periods of time.

Olinger et al. (1975) stated that the status of finfish populations and fisheries in Escambia Bay were judged to be in an intermediate stage of recovery. Various biological parameters indicated that many environmental conditions underwent large improvements during the five years from 1970 - 1975. Recent fish kills and declines in crab harvests in the mid 1980's have led many residents to wonder if the trend has reversed.

The yield of sport and commercial fishes is one of most tangible expressions of productivity. However, the quality and applicability of the data are limited. There may be several reasons for stock declines, but until such time as the biology of these species is known, no certain evaluations of pollution, habitat loss or gain, or other management factors can be made.

1.6 Water Quality

Water quality parameters have received the most attention in monitoring programs and discussions of the "ecological health" of estuaries for the obvious reason that organisms live within the medium and are subject to all the fluctuations, both natural and artificial that occur within the water column. Estuaries, in general, have a large capacity to absorb and assimilate most of the pollutants that are introduced into them. However, when artificially stressful conditions occur simultaneously with naturally extreme conditions (e.g., low freshwater input and high temperatures) sometimes the conditions become lethal to the organisms. The results are expressed as visible fish kills or grassbed declines. Difficult to assess, however, are the sublethal effects of perturbations, such as reduced reproductive output and adult size. In addition, the synergistic effects produced by the interaction of various artificial inputs are not well known at present.

a. Overview

The interpretation and compilation of the available water quality data was hampered in many instances by difficulties encountered with the different sampling techniques and analyses used by various investigators, in addition to unrecorded physical conditions at the time of sampling such as tidal state, winds, and precipitation that are known to cause significant variation in water quality parameters. Also, sampling stations were not in the same location in many cases and this contributed additional variability to the results. Moreover, there should be a good understanding of normal year-to-year variations in certain parameters if the eutrophication process and artificial influences on the system are to be understood. Ideally, there should be water quality and meteorological condition data over the last several decades that have been examined. These do not appear to exist and are known only in general terms.

Florida has a classification scheme for coastal waters that ranges from Class I through V. Each has general water quality standards that apply to it (Chapter 17-3, F.A.C.). All of the waters within the Pensacola system are Class II or Class III waters. Class II water quality criteria are designed to permit the harvesting of shellfish for human consumption. Class III criteria provide satisfactory water quality for the propagation and maintenance of fish and wildlife and for recreational activities. There are no mandatory Federal water quality standards specific to Florida. However, Florida water quality standards are subject to review and approval by the USEPA pursuant to Section 303 of the Federal Water Pollution Control Act Amendments of 1972.

b. Historical Perspective

Water quality characteristics were monitored as early as the 1950's in the Escambia River and Bay. Prior to industrial effects, the lower Escambia River was reportedly free of pollution (Academy of Natural Sciences of Philadelphia, 1953). In 1958, industrial inputs began to adversely affect estuarine organisms in northeast Escambia Bay (Florida State Board of Health, 1958). Regular investigations into the water quality of the Pensacola Bay system began in 1969 (Hopkins, 1969, 1973; Tisdale and Young, 1969). A major study was conducted by the EPA in 1974 (Olinger et al., 1975). In 1979, 1980, 1981, and 1983-1984, studies were conducted by the Environmental Analysts of Florida, Inc., City of Pensacola, and the Escambia County Utilities Authority (ECUA) respectively. The ECUA (1984) reviewed past records for comparison to their present work and documented changes in conditions throughout the past 20 years and "demonstrate(d) that Pensacola Bay recovered from a very stressed condition noted in the 1960's and maintains an environmentally healthy condition today." The DER has conducted numerous hydrolab (water quality) surveys of various portions of the system as well as surveys in response to isolated incidences such as railroad derailments and fish kills.

The Center for Government Responsibility at the University of Florida (1976) reported that overemphasis upon industrial water pollution in the area "would be both unwise and unfair". The people of the region must bear their fair share of correcting the increasingly apparent problems of urban expansion; nonpoint source discharges of unconcentrated but nonetheless chemical pollutants; stormwater and construction runoff; bayou sedimentation; beach erosion or discoloration; overloaded sewage system; adverse effects on upland vegetation, particularly from septic tanks. Typical regional problems are associated with unplanned residential development in particular and uncontrolled coastal growth in general (Center for Government Responsibility, Univ. Fla., 1976).

c. Water Quality Parameters

Nutrients.

(1) Nitrogen - During 1974, the mean concentration of total nitrogen in Escambia Bay exceeded the reference standard of 0.360 mg/l. More than half the time the limiting nutrient for phytoplankton in the Pensacola Bay system appeared to be phosphorus. Mean nitrate-nitrite concentrations in the system

during January - September, 1974, decreased in seaward direction from Escambia River to lower Pensacola Bay. Nitrate-nitrite was the only nitrogen parameter that showed this upper to lower bay pattern.

Some localized elevations in nitrogen concentrations near waste outfalls in the system have been detected by various investigators (e.g., McAfee, 1984). These have occurred in northeast Escambia Bay, near the Main Street outfall, and near Bayou Texas. Organic nitrogen, ammonia, and nitrate-nitrite concentrations were generally elevated in these locations.

From January through September, 1974, Pensacola, East, and Blackwater Bays had virtually identical nitrogen concentrations. The major portion of nitrogen in the Pensacola system was organic nitrogen. Total nitrogen concentrations in Escambia and East Bays during the August, 1973, low-flow diel (24-hr) water quality surveys were noticeably higher than concentrations during the April high-flow surveys. This condition probably reflects higher biological productivity in the summer, rather than flow conditions.

From 1969 - 1974, nitrogen concentrations decreased and Olinger et al. (1975) viewed this as an indication that water quality improved during the five years.

The first study to present nitrogen information on Pensacola Bay was the City of Pensacola monitoring report (1979). In this report, total nitrogen concentrations were in excess of those found in 1983 - 1984 (McAfee, 1984). Organic nitrogen comprises a major portion of the system, other forms are not very significant. Mean total nitrogen concentration in Pensacola Bay was similar to Choctawhatchee Bay which was 0.256 mg/l or 0.104 mg/l below the nutrient index recommended in Water Quality Criteria (1971). Mean total nitrogen for the 1983 - 1984 ECUA study exceeded 0.360 mg/l in 2 of 10 stations. Both stations were at the Main Street WWTP effluent discharge. Eastern outfall locations had nitrogen levels that averaged 0.39 mg/l while the center boil of the effluent averaged 1.14 mg/l.

Young (DER Interdepartmental Memo, 1985) reported the average annual total nitrogen levels from an increase in station (PNS) within Escambia Bay from 1974 to 1985 Table 1.5.

Table 1.5. Total nitrogen measured in Escambia Bay (PNS station, FL. DER, unpublished data).

	Total nitrogen (mg/l)
1974	0.396
1975	
1976	0.456
1977	0.490
1978	0.476
1979	0.568
1980	0.685
1981	0.580
1982	0.520
1983	0.460
1984	0.545
1985	0.754 (4-30-85)
1985	0.640 (7-17-85)

(2) Phosphorus - Various reports have indicated that the Pensacola system is phosphorus limited. Three forms occur most frequently, orthophosphate, polyphosphate, and organic phosphate. Phosphorus is usually present in an insoluble form in an estuary because: (1) much soluble phosphate is taken up into cell mass and kept out of solution; (2) phosphate is readily adsorbed onto insoluble residues in the water, and; (3) the pH is in the range (slightly basic) in which phosphate forms an insoluble precipitate. The upper acceptable limit for total phosphorus in the system is approximately 0.05 mg/l (Olinger et al., 1975).

Young (DER Interdepartmental Memo, 1985) reported that total phosphorus levels were 0.15 mg/l in July 1985 samples which greatly increased the potential for algal blooms.

The concentration of orthophosphorus dropped by 50% between 1969 - 1974, while total phosphorus concentrations decreased by 75% (Olinger et al., 1975). McAfee (1984) noted that there was a gradual decrease in phosphorus concentration since 1981 ECUA study.

(3) Carbon (Total Organic Carbon or TOC) - From surveys conducted in 1974 by Olinger et al. (1975), mean TOC concentrations in all portions of the Pensacola Bay system were greater than the 2.0 mg/l standard with only two exceptions. Therefore, sufficient carbon was usually available in the system to theoretically cause the DO concentrations in the waters to be depressed below the concentrations specified in the Florida Water Quality Standard. Mean TOC during 1974 water quality surveys were distributed uniformily throughout Escambia Bay. Mean

concentrations throughout the bay were generally lower than those in the river. Olinger et al. (1975) reported that there were no obvious increases in TOC concentrations near the waste water discharges during their 1974 sampling period.

Throughout East and Blackwater Bays, the mean TOC concentrations were essentially the same during January through September 1974. In Pensacola Bay, TOC concentrations generally decreased in a seaward direction with the lowest mean concentrations occuring at the western end of Santa Rosa Sound. During 1974, mean TOC concentrations in Escambia Bay were statistically higher than in Pensacola and East Bays.

(4) Nitrogen to Phosphorus ratio (N:P) - This index uses total nitrogen and total phosphorous concentrations. It is a criterion, similar to the Principal Nutrient Index discussed below, for determining nitrogen balance in a system. A standard value of 7.25:1 is obtained based on weight. This value applies to open ocean waters but generally not for highly productive estuaries. Olinger et al. (1985) reported the following mean values for bays within the system from January through September 1974: Escambia Bay - 14.6:1; Pensacola Bay - 10.5:1; East Bay 18.5:1, and; Blackwater Bay - 14.6:1. All these values indicated that nitrogen was usually available in sufficient amounts and that phosphorus would be the limiting nutrient for phytoplankton. McAfee (1984) reported that the total mean N:P ratio for June 1983 through July 1984 in Pensacola Bay was 7.02:1. He interpreted this to indicate a "drastic improvement" in bay conditions since Olinger et at.'s (1975) study.

Principal Nutrient Index (PNI).

Olinger et al. (1975) introduced the use of Harkin's (1974) Principal Nutrient Index (PNI) for the nutrient data present from the Pensacola Bay system. Total nitrogen, total phosphorus, and total organic carbon were the three nutrients used in the calculation of the PNI. The index is an effective water management tool because it allows an investigator to combine three parameters into one, thereby simplifying the evaluation of nutrient levels in a system. The standard PNI value used for the Pensacola system was 9.0 based on levels of 0.36 mg/l for total nitrogen, 0.05 mg/l for total phosphorus, and 2.0 mg/l for total organic carbon (Olinger et al., 1975). A sample with a PNI above 9.0 is considered nutrient enriched.

Several trends in PNI values were reported by Olinger et al. (1975) during their study. Escambia Bay had the highest PNI values of all bays in the system. PNI values appeared to have decreased in Escambia Bay from 1969 to 1973. During September 1969, 91% of the PNI values exceeded 9.0. In Escambia Bay in 1974, 50% of the stations had PNI values that exceeded 9.0.

However, in Pensacola and Blackwater Bays, less than 25% of the stations had PNI values over 9.0. East Bay had the lowest number of high PNI values in the entire system in 1974.

Mean surface and bottom PNI values in Escambia and East Bays were higher than values in the Escambia River inflow indicating the importance of the contribution from sediment resuspension. High PNI values occurred when Escambia River discharges were high and low values occurred during low flow periods. Mean PNI values generally followed the river discharge trend for each bay in the system. In Pensacola Bay, the highest surface PNI values were present near the Main Street STP outfall. In general, PNI values decreased in a seaward direction throughout the system.

McAfee (1984) reported that the mean PNI values in Pensacola Bay during July 1983 through July 1984 for surface, mid, and bottom depths were 7.44, 5.91, and 8.65, respectively, with an overall average of 7.33 (note the 9.0 standard established by Olinger et al., 1975). The values were influenced by one station in the center of the Main Street STP discharge. Since values were lower than the standard even with the high station considered, McAfee (1984) interpreted this as an indication that the bay was not in a stressed condition.

Oxygen.

Dissolved oxygen (DO) concentrations in waters are affected by a number of different factors: (1) inflow of tributaries; (2) oxidation of organics; (3) inorganic reactions; (4) photosynthesis; (5) turbulence; (6) temperature, and; (7) salinity. In 1969, the Florida State Health Department reported readings in the system ranged from 4.2 - 8.9 ppm. In 1974, DO levels were near saturation for the surface stations, deeper stations had lower values. Mean bottom DO concentrations were usually lower in East Bay than in Escambia from January - May, 1974, and higher after May, 1974. There was an inverse correlation between DO and salinity. Olinger et al. (1975) reported that DO concentrations in Escambia Bay appeared to have improved between 1969 and 1973 through 1974.

During the 1974 EPA study, there were two periods of low DO, one in the early spring and the other in the late summer. This pattern has also been noted in several other reports (Livingston, 1977; DER various memos). The period in early spring typically occurs after high river inflows and the one in the summer occurs when salinities in the system are high due to low freshwaters inputs. When the system becomes vertically stratified, oxygen is not transported from the upper layer, which undergoes reaeration, to the lower layer which must satisfy the BOD (Biochemical Oxygen Demand).

Based on data from East Bay, low DO concentrations occur during critical periods (e.g., high temperatures and low river inflow) even in the bays that do not directly receive point source waste discharges (Olinger et al. 1975). Consequently, due to the naturally poor circulation in the Pensacola Bay system, the assimilative capacity of the system with respect to oxygen resources is extremely limited.

During a 1979 bay monitoring program, August - October DO readings were taken at three depths: bottom DO readings ranged from 0.5 - 4.7 ppm and surface readings reached as high as 8.5 ppm (Brown, 1979). In 1981, the ECUA reported that DO concentrations at mid-depth and subsurface stations overall were good in relation to temperature and salinity (Shuba, 1981). Some DO concentrations were below the defined acceptable 2.0 ppm level. Shuba (1981) reported that the Main Street STP discharge did not affect the usually low summer DO concentrations. Moshiri et al. (1980) reported that the Santa Rosa Sound area had relatively high DO concentrat-ions. In 1984, the ECUA reported that DO averages for bottom depths were 5.1 - 6.5 ppm. The lowest single reading was 3.0 ppm. In a 1983 survey, Young and Butts DER, Interdepartmental Memo) stated that DO was generally good for normal aquatic life for the Pensacola area. The extremes of DO supersaturation associated with eutrophication were absent, indicating improvements in the bay. According to the 1983 - 1984 ECUA survey, DO conditions improved from the 1974 EPA study (McAfee, 1984). Surface DO concentrat-tions were in the same range as samples taken in 1974, with higher concentrations reported for the bottom samples taken during the study indicating a healthier condition for Pensacola Bay.

The water column can be extremely stratified such that bottom DO concentrations may be below the limit for organisms to survive. Young, Ray, and Butts (DER, Interdepartmental Memo, 1983) noted that the Blackwater-East Bay region had a history of fish, crab, oyster, and clam kills from the mid sixties to the seventies. Blue crab fishermen have complained in the past of crabs dying in pots that happen to be placed within low DO bottom water. The situation appears to be the result of over nutrification. DO levels occasionally become very low (0.8 - 1.2 ppm) in water deeper than 6 ft. Young, Ray, and Butts (1983) noted significant reductions in DO above the Yellow River confluence. They postulated that the Milton STP was the major source of nutrients contributing to the low DO levels. The present DO problems in Blackwater Bay are more acute than Escambia Bay possibly indicating that the Milton STP needs upgrading (Young, 1981; Young, Ray, and Butts, 1983).

Biochemical Oxygen Demand (BOD).

There are no BOD limits for estuaries with the exception that in Class II and III waters, BOD shall not be in excess to cause the DO content to drop below 4.0 ppm. A 1969 report by DER stated that BOD levels for Pensacola Bay were generally high for bay waters, however, only 4 out of 42 BOD analyses were above standards. The only other report to consider BOD information other than the 1983 - 1984 ECUA study was one by Moshiri (1980) which stated that high DO's were found in conjunction with high BOD's in Santa Rosa Sound. BOD concentrations for the 1983 - 1984 ECUA report were all below 2.0 ppm and generally accompanied by high DO's. According to the Florida DER standards, this is considered a healthy condition. Results of the 1974 EPA study indicated no difference or appearance of excessive BOD levels in Escambia Bay between 1973 and 1974 (Olinger et al., 1975).

Turbidity.

Water turbidity or clarity can be a highly variable parameter on a daily basis. Measurements are generally made with a Secchi disc. Turbidity readings have not been historically collected at fixed stations so comparisons of any data are tenuous at best.

d. Causative Factors of Water Quality Degradation

Olinger et al. (1975) reported that point source wastewater discharges were the major cause of poor water quality conditions in Escambia Bay during the late summer. However, non-point sources and tributary river inflow also contributed to poor water quality conditions. Pensacola Bay proper receives the greatest quantity of BOD material and significant amounts of total nitrogen and phosphorus from nonpoint sources (Olinger et al., 1975). Escambia Bay receives the lowest quantities for each pollutant, because the bluffs on the west shore of Escambia Bay prevent most urban storm water runoff from entering the bay. The majority of this runoff enters the bay system through Bayou Texar which received 14% of BOD, 10% of total nitrogen, and 11% of total phosphorus discharge to Pensacola Bay system in 1974 (Olinger et al., 1975).

Because of poor circulation and flushing characteristics, the assimilative capacity of the Pensacola Bay system is extremely limited and the bay is barely able to assimilate natural inputs of nutrients and oxidizing materials (Hopkins, 1973; Olinger et al., 1975). The situation can become critical during particular times of the year when natural conditions such as low river inputs and high temperatures are already at stressful levels.

Causative Agents.

The following discussion concerns only surface water contaminants; pollutant discharges from ground water entering estuarine waters have not been documented in the system.

Point Sources(Figure 1.7)

a) Domestic Waste - Major characteristics are high BOD, high suspended solids, and high coliform bacteria. Municipal wastes are decomposable organic material, discharged from toilet, kitchen, and laundry facilities, and carried in sewer lines. Material consists of carbohydrates from plants and paper, proteins from animal and plant matter, and miscellaneous fats and oils. Organic material as a source of nutrients alone are not necessarily detrimental. In excess, however, they reduce the level of DO in water and result in the development of new fauna and flora, particularly objectionable algae.

Chlorinated effluents - The ecological impact of chlorine and its by-products on aquatic environments has not been adequately measured or evaluated largely because diagnostic techniques for chlorine are undependable. At relatively high

Municipal Point
<u>Source Facilities</u>

1-Andalusia
- North side disposal plant
- West side treatment plant
- South side disposal plant

2-Brantley WTP
3-Brewton WTP
4-East Brewton WTP
5-Evergreen
- Plant #1
- Plant #2

6-Fort Deposit WTP
7-Greenville WTP
8-Luverne WTP
9-Troy
- East side WTP
- West side WTP

10-Century WTP
11-University of West Florida
12-Pensacola, Northeast WTP
13-Pensacola, Main St. WTP
14-Warrington WTP
15-Pen Haven WTP
16-Gulf Breeze WTP
17-Pensacola Beach WTP
18-Milton WTP
19-Crestview WTP

Industrial Point
<u>Source Facilities</u>

A-Container Corporation of America
B-T.R. Miller
C-Exxon Corporation
D-Alger-Sullivan Lumber Co.
E-Gulf Power
F-Monsanto
G-Air Products Co.
H-American Cyanamid Co.
I-NAS Whiting Field
J-NAS Pensacola

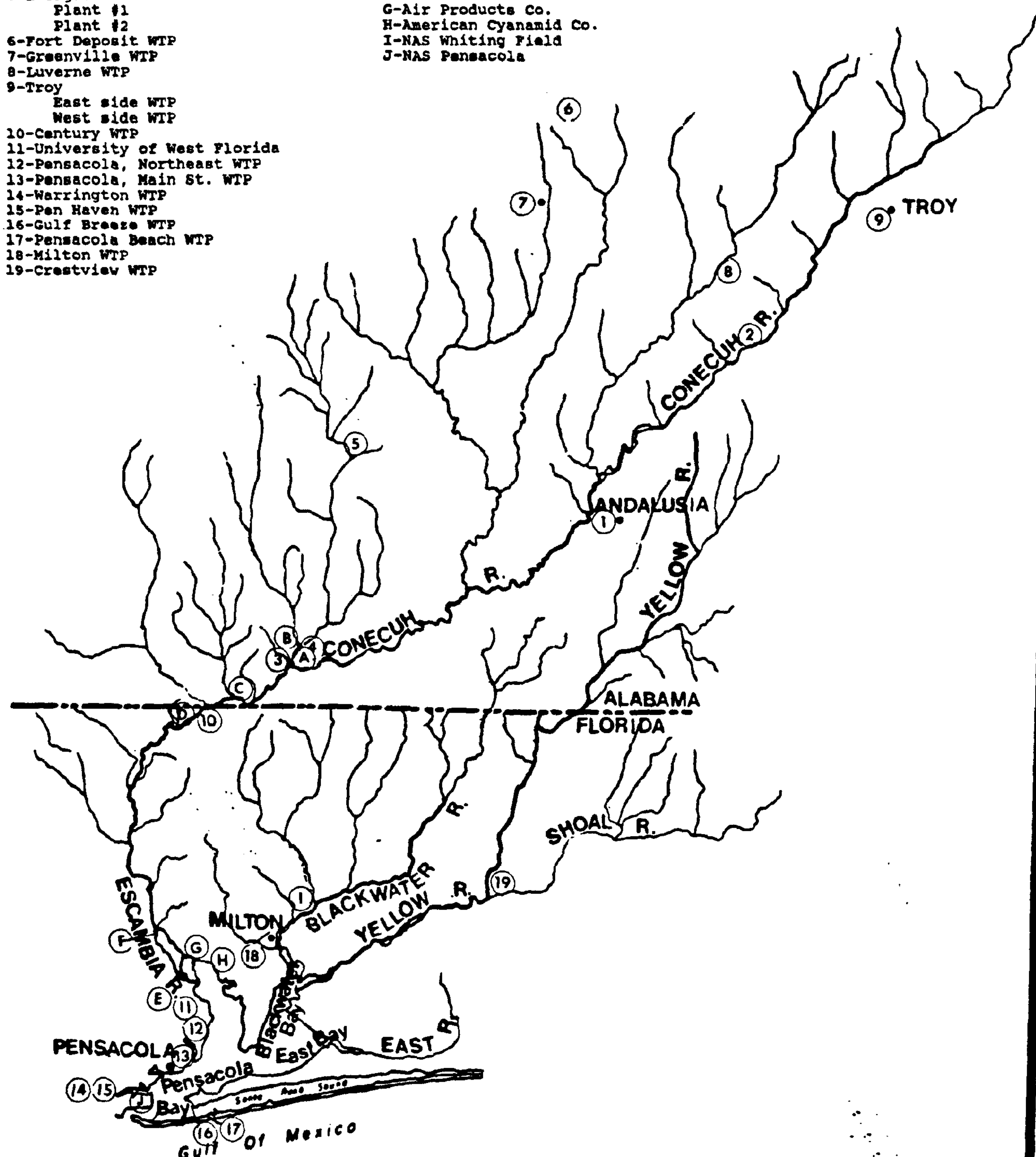


Figure 1.7 Major point-source discharges.

chlorine concentrations, the growth of most phytoplankton decreases and mortality increases largely because of the impairment of photosynthesis. Chlorine may be a factor in the decline of large areas of submerged grasses in Mobile Bay and it seems certain that chlorine is a contributing factor in damaged areas directly receiving industrial effluents (O'Neil and Mettee, 1982).

Four main WWTP's discharge into the Pensacola Bay system:

1) Main Street WWTP - is operated by ECUA. The plant's operating design capacity is 20.0 mgd and the average flow is 11.0 mgd. The service area is primarily southern Escambia County. The effluent is discharged 6,109 ft out into Pensacola Bay in 23 ft of water. Approximately 95% of the effluent is domestic, while the remaining 5% is industrial.

2) Milton WWTP - is operated by the City of Milton. The plant's design capacity is 2.5 mgd with an average flow of 1.5 mgd. The plant has had a history of raw sewage by-passing the plant and discharging into the Blackwater River during periods of heavy rainfall. It was renovated in 1984. Effluent is discharged 423 ft out into the Blackwater River.

3) University of West Florida WWTP - UWF operates a 0.5 mgd plant. It serves approximately 5,000 people. The average flow from October 1983 to October 1984 was 0.174 mgd.

4) East Milton Elementary WWTP - Santa Rosa County School Board operates the East Milton Elementary School WWTP. The plant capacity is 0.005 mgd. It serves 425 people. The average flow from November 1983 to November 1984 was 0.003 mgd.

Septic Tanks - Septic systems can have a significant detrimental effect on environmental quality especially in the forms of water-borne diseases and nutrient loading. However, little definitive research and documentation is available. Septic tank systems work well in rural low density areas with suitable soil and a deep water table. Many areas immediately surrounding the Pensacola system are rapidly becoming high density population centers, usually low-lying and subject to periodic inundation, and comprised of coarse, sandy soil that is an ineffective filtration medium. Three major potential problems are associated with septic tanks in coastal areas:

(1) wastes are leached into coastal waters when septic tanks are located too close to the shore;

(2) tidally-induced high water tables provide direct and rapid flushing of drainfields into coastal waters;

(3) inadequate drainfield components or soil-absorption characteristics cause tanks to overflow, particularly during rainstorms, and pollute coastal waters.

The majority of septic tanks within the Pensacola system are not adjacent to the shoreline (Barnett and Gunter, 1985). Waterfront septic tank systems account for 26% of the systems within the area.

b) Industrial Waste - Four major industries discharge treated industrial wastes into the surface waters of the Pensacola system:

1) Air Products and Chemicals, Inc. - began operation in 1955 and produces agricultural chemicals, polyvinyl chloride (PVC) plastics, industrial organics, and inorganics including chemical intermediates. It operates a 1.5 mgd wastewater treatment facility. Table 1.6 gives annual loadings of the plant to Escambia Bay.

Table 1.60. Annual loadings (lbs/yr) to Escambia Bay by Air Products (FL DER, unpublished data).

Year	Total N	T/PO4	TSS	T/COD
1974	367,765	10.096	97,313	376,814
1975	331,604	11,710	73,964	381,162
1976	314,987	8,340	72,579	314,511
1977	170,371	9,260	60,784	308,505
1978	210,315	9,576	68,097	403,736
1979	181,824	9,438	62,045	376,324
1980	124,365	6,314	67,106	332,022
1981	70,385	3,930	46,230	287,948
1982	88,825	5,344	55,017	337,258
1983	91,435	6,411	53,361	311,074
1984	89,234	5,637	63,939	282,569
1985 (Thru	117,697	5,435	48,426	299,634
1986 June)	49,328	3,743	33,410	168,921

2) American Cyanamid - a synthetic fiber manufacturer producing acrylic polymers from acrylonitrile and methyl-methacrylate monomers. It operates a 5.0 mgd wastewater treatment system. Average flow for the period between January - June 1983 was 1.65 mgd. The effluent may be disposed of by surface discharge via a submerged pipeline 5,000 ft into Escambia Bay or 50% of the effluent is treated by spray irrigations via one or two spray heads at a time at a rate of 500 gal/min onto an 80 acre site. Table 1.7 gives annual loadings of the plant to Escambia Bay.

Table 1.7. Annual loadings (lbs/yr) to Escambia Bay by American Cyanamid (FL DER, unpublished data).

year	BOD	TSS	TN	Different Permit Limits
1976	169,360	144,540	317,915	
1977	35,770	109,500	211,335	
1978	73,000	97,090	187,610	

1979	51,465	101,105	176,660
1980	27,740	78,110	166,805
1981	20,440	60,955	119,720
1982	21,535	41,610	95,630
1983	26,280	38,325	111,690
1984	30,368	43,800	144,905
1985 (Thru	22,964	55,449	132,738
1986-July)	11,145	32,345	35,373

Both American Cyanamid and Air Products hydrographic studies indicate that the waste from their outfalls tends to accumulate near the upper eastern shore of the bay. This tendency to accumulate industrial waste is significant in regard to public health. It was recommended by Barnett and Gunter (1985) that any construction, dredging, or other activities that have the potential to suspend the sediments of the northern portions of Escambia Bay be closely reviewed and monitored to provide maximum public health protection.

3) Gulf Power - Gulf Power Corporation operates the Crist Electric Generating Plant located in Escambia County 3.3 miles upstream from the mouth of the Escambia River. The Crist plant consists of 7 fossil fuel electric generating units. Condenser cooling water for five of the units is drawn from Governor's Bayou, a tributary of the Escambia River, and passed through a cooling tower before it is discharged via a 5,000 ft canal into the Escambia River approximately 4.5 mi north of shellfish growing areas.

4) Monsanto Chemical Company - began manufacturing in December 1953. Nylon production increased 700% from 1953 to 1972 (EPA, 1975). Process-generated wastewater is routed for treatment, while stormwater is routed into the Escambia River through permitted discharge points. The overall system is designed to divert the first inch of rainfall to processing in the waste treatment system and the remaining clean flow is rerouted into the river.

Concentrated wastes generated at the plant are collected and disposed of in 3 deep-injection wells with a total capacity 2,400 gal/day. The wastes are injected into the lower limestone of the Florida Aquifer at a depth between 1,600 and 1,800 feet. The plant has 2 river discharges comprised of mainly once through cooling waters and collected stormwater runoff. Table 1.8 gives annual loadings of the plant to the Escambia River/Bay.

Table 1.8. Annual loadings (lbs/yr) to the Escambia River/Bay by Monsanto (FL DER, unpublished data).

Year	BOD 5	TN	Total P
1976	256,595	131,765	8395
1977	260,610	137,240	10585
1978	304,045	129,940	10220
1979	429,970	142,715	7665
1980	209,145	89,060	7665
1981	147,825	49,640	5475
1982	206,225	44,895	2920
1983	141,985	45,265	4745
1984	140,525	55,480	3650
1985	108,618	44,256	3407
1986 (Thru June)	33,334	16,688	1538

Nonpoint sources (Table 1.9) -

There are several sources that are considered nonpoint:
1) urban stormwater runoff;
2) agricultural runoff, and;
3) forest and swamp drainage and runoff.
All these are slug-type discharges that occur during a rainstorm.

Surface runoff from agricultural lands contributes to water pollution by transporting biocides (insecticides and herbicides), and nutrients (fertilizers) by increasing erosion of disturbed soil and associated sedimentation, and by pathogenic bacteria and viruses from excrement in feed lots and pastureland. Usually individual farms do not substantially contribute to downstream pollution but collectively they do.

Table 1.9. Average non-point source pollutant discharge into reaches of the Pensacola Bay System (Olinger *et al*., 1975).

		(kg/day)		
Basin	Area(km^2)	BOD	Total N	Total P
Escambia Bay	126.9	433	92	29
Pensacola Bay	148.7	1337	202	69
Blackwater Bay	316.2	884	280	73
East Bay	236.7	457	102	37

Potential water contaminants, primarily from the use and storage of motor vehicles, accumulate on impervious surfaces between storms. Direct runoff from these surfaces into the bay may have detrimental effects on estuarine habits. Runoff should be prevented from entering the bay and directed to infiltation devices. In areas where a high water table or dense soils do not allow infiltration, wet ponds or shallow marshes may be constructed to accept the first half inch of runoff.

The size and complexity of stormwater management problems are proportional to the amount of impervious surface created by development. Therefore, an area that limits the amount of impervious surface in a development will have fewer problems related to excess runoff than one with large areas of imprevious surface.

The maximum desirable percentage of impervious surface in a particular area will vary depending on local conditions. Important factors related to runoff are infiltration rates of soils, depth to the water table, and the area available for infiltration devices, wet ponds, and shallow marshes.

1.7 Sediment Contamination

a. Introduction

Natural forces such as erosion and weathering are constantly releasing metals, nutrients, and organic matter from upland regions while rivers and streams eventually transport these materials downstream to the estuary. In addition, these substances are introduced into a waterway through artificial means such as sewage treatment plants, over and above their natural levels. The majority of pollutants entering estuaries are bound to sediment particles (particularly clays and hydrated iron oxides) that rapidly settle and become incorporated into the bottom. Estuarine sediments essentially act as a sink for many constituents. Therefore, sediments are good indicators of the pollution condition of an estuary. Sediment chemistry may provide a more comprehensive evaluation of the pollution in an estuary than water quality which is generally the accepted standard (Ryan et al., 1984).

Traditionally, regulatory processes in estuarine environments have placed an overemphasis on water quality considerations as a basis for decision making, with near disregard for other equally important factors. Recently, the FL DER has stressed the need to examine estuarine geochemistry, with a focus on the sediments. The FL DER states that water quality standards alone fail to provide an adequate basis for managing estuarine environments and have recommended that closer attention be paid to the sediments which are the main repository of pollutants from man's activities.

Seasonal chemical variations in sediments, exclusive of nutrients (e.g., nitrogen and phosphorus) are not likely to be appreciable as is often the case with watert column parameters. In addition, sediment sampling strategies can take into account the geographical distribution of sediment types. The FL DER uses metal-to-aluminum ratios to detect potential environmental problems as opposed to simple concentrations.

Most of the particulate material entering the Pensacola Bay system from point and nonpoint waste sources and tributary rivers are retained in the system. However, this material is distributed throughout the bays before sedimentation occurs. Thus, the effects of waste discharges are bay wide.

b. Synthetic Organics

Polychlorinated biphenyls (PCBs) - PCBs, in general, are extremely stable and exhibit little degradation in the estuarine environment because of their insolubility in water and relative thermal stability. PCBs are used in formulating plastics, resins for rubber-based lacquers, varnishes, paints, lubricants, heat-transfer fluids, and electrical insulators.

Aroclor 1254 (a trade name for a PCB) has been continually detected in the bay sediments since its release in 1969 when an accidental leak of heat-exchange fluid from the Monsanto Chemical Company plant into the Escambia River occurred. Higher concentrations were generally present in the finer-sized particles, especially channel sediments near the industrial waste discharges in the northeast portion of Escambia Bay.

Olinger et al. (1975) reported PCBs from sediments throughout the bay system. Concentrations ranged from 0. - 1500 ug/kg (ppb). The highest concentration was located in the Escambia Bay barge channel. There was a general trend of higher PCBs in the finer particles throughout the system. PCBs eventually accumulate deeper into the sediments where they can not readily affect organisms, etc. This situation has occurred over the past years til the present when they no longer present a threat to estuarine life unless dredging or other sediment disruptive activities uncover them.

c. Pesticides

Olinger et al. (1975) analyzed the sediments for 21 pesticides. Five were detected. DDE (a derivative of DDT) was found in the sediments of Blackwater, East, and Pensacola Bays but not in Escambia Bay. Concentrations ranged from nondetectable to 1.9 ug/kg. Dieldrin was found only in Escambia Bay 0.12 - 0.43 ug/kg at 4 of 13 stations. Dieldrin is highly toxic and probably entered the system through lawn fertilizer and ant control measures.

d. Metals

In general, all metal concentrations are higher in muddy sediments than in the coaser-grained sandy sediments within the bay system. (Note: Joe Ryan or Graham Lewis in DER's Office of Coastal Management should be contracted for sediment chemistry on numerous metals, synthetic organics, and nutrients in the Pensacola Bay System. Considerable work has been done and detailed data are avilable.

Lead.

Higher concentrations are generally present in the mid-portions of the bays. Olinger et al. (1975) reported that muddy portions of the system had concentrations 10 - 38 ug/g except Bayou Texar and Chico - that were at 54 and 64 ug/g respectively. Higher concentrations (by a factor of two) were present below the L & N railroad trestle in comparison to other regions throughout the bay. Concentrations in East Bay were approximately the same as lower portions of Escambia Bay. Five stations along the north margin of Pensacola Bay and in the bayous along the north shore had concentrations that were highest for the entire bay system. These stations were influenced by the City of Pensacola's wastewater discharges. Lead concentrations in Escambia Bay did not seem excessive (Olinger et al., 1975) and were lower than Mississippi coastal areas, Chesapeake Bay, Galveston Bay, and Mobile Bay.

Zinc.

Concentrations were lower in shallow sand stations in comparison to deeper muddy stations in the entire system. Upper Escambia Bay had lower concentrations than the lower bay within mud stations. Bayou Texar had high concentrations (150 ug/g) compared to the highest concentration of 85 ug/g in Escambia Bay. Bayou Chico had a concentration of 1200 ug/g in its mud which is very high when compared to other systems. Generally, Escambia Bay had lower concentrations than Pensacola Bay.

Donelan (DER Interdepartmental Memo, 1984) noted zinc concentrations in a survey of Monsanto outfalls into Escambia River. Zinc concnetrations were higher than backgroumd levels, but within permits limits, in South outfall. The North outfall (also called the North Ditch) was in violation of section 17.3, FAC (Class III waters) for zinc.

Ryan (personal Communication) noted relatively high zinc-to-alumium ratios (i.e., in the polluted range) in samples taken at various locations in the Pensacola Bay in the fall of 1985.

Chromium, Cadmium, Manganese, Nickel, and Aluminum.

All concentrations of these metals did not exceed background levels in the system (Olinger et al., 1975). Donelan (DER Interdepartmental Memo, 1984) noted that chromium in North Creek was elevated high above background levels. Ryan (personal communication) noted elevated chromium-to-aluminum ratios at numerous stations in pensacola Bay in fall 1985 samples compared to background levels.

Copper.

Sandy areas generally had lower concentrations of copper than muddy stations within the Bay system. Muddy stations in upper Escambia Bay had lower concentrations than muddy stations in lower Escambia Bay. East Bay copper concentrations were lower than either upper or lower bay portions of Escambia Bay. Mulatto Bayou and Bayou Texar concentrations were 10 ug/g, Bayou Chico had a concentration of 120 ug/g. These values compare to East Bay - 4.4 ug/g, Escambia Bay system - 8.7 ug/g that were some what contaminated with copper. Pensacola Bay (19.3 ug/g) had a higher value than the Escambia system. Concentrations around discharges of American Cyanamid and Air Products were higher than other stations in the upper bay. Copper apparently was accumulating in an area near the discharges.

Iron.

Was not reported in excessive concentrations (Olinger et al., 1975).

Cobalt.

Accumulations of cobalt in lower portions of Escambia Bay within deeper water sediments were higher than adjacent bays.

Vanadium.

There is a greater accumulation of vanadium in lower Escambia Bay compared to East and Pensacola Bays.

Titanium.

There was a uniform distribution in Escambia Bay regardless of depth or sediment type. Similar concentrations in East Bay, Pensacola Bay was somewhat lower.

Summary.

The channel sediments from the Escambia Bay generally differ from those found in the central bay mud plain (Olinger et al., 1975). High river flows cause periodic scouring of river bottoms and the suspended fine sedimentary material tends to accumulate in the channel areas. The channel is generally deeper than the surrounding bay bottom and acts as a sediment sink for mud fractions. Channel-accumulated mud sediments contain high PCB's and heavy metals. These sediments may be periodically resuspended by high river flows and deep-draft vessels.

e. Benthic Community

As mentioned previously, sediments prove to be a valuable parameter to examine in terms of metal and nutrient pollution. In addition, changes in the composition (i.e., species present and density) of the benthos (or bottom-dwelling organisms) can reveal much about the pollution state of an estuary. The majority of the benthos is comprised of small organisms (i.e., milimeters in length) such as polychaete worms, various crustaceans, and bivalves. The benthic community is a critical component of the estuarine ecosystem for a number of reasons. A primary one is that many of the organisms are food for important recreational and commercial fish species. Many benthic organisms are classified as pollution-sensitive or pollution-tolerant based upon studies of their natural histories and tolerances for degraded conditions. Although revealing much about pollution inputs, benthic analysis are extremely labor intensive to conduct. Samples must be collected, sieved, and animals sorted out and indentified.

Typically, unpolluted waters are characterized by a large number of species with a relatively low number of individuals per species (i.e., high diversity). In polluted waters, fewer species are present and a portion of these are dominated by a large number of individuals (i.e., low diversity). A change in benthic community structure can result in concomitant alterations higher in the food chain.

Upland activities may affect the benthos in a number of ways, for example by: changing the average sediment particle size, increasing the concentration of toxic substances, and increasing the amount of nutrients. A change in the particle size of the sediment is an important factor that results in the alteration of benthic community structure. In addition, estuaries can be strongly stratified with respect to DO on a seasonal basis. Often times the bottom-water layer just above the sediment becomes anoxic (oxygen depleted). As such, benthic life is nearly nonexistent.

Several of the aforementioned situations have been observed in the Pensacola Bay system. One of the earliest accounts comes from young (FWPCA, Interdepartmental Memo, 1972) who reported that conditions in the northeastern area of Escambia Bay near the Air Products and American Cyanamid outfalls declined severely from 1968 to 1971. Species diversity was greatly reduced. The area was dominated by "pollution-tolerant" organisms such as Balanus eburneus (barnacle), Neanthes succinea (polychaete worm), and Callinectes sapidus (blue crab). Normally, abundant organisms such as amphipods, isopods, cumaceans, mysids, shrimp, xanthid crabs, and molluscs were rare or absent. In addition, the typical vegetation such as Ruppia and Vallisneria was replaced by a blue-green algal film and other algal species.

Olinger *et al*. (1975) and Cooley (1978) represent the major works reporting benthic species present within the system. Cooley (1978) presented an extensive species list and noted the habitat and season that each one was caught. Olinger *et al*. (1975) worked in Escambia Bay and related benthic distributions to sediment type and pollution discharges. They reported three distinct benthic assemblages: mud, sand, and transitional. The sand assemblage represented approximately 25% of the bay bottom; the mud assemblage represented approximately 70% of the area, and; the transitional zone assemblage accounted for the remaining 5% of the bottom.

Olinger *et al*. (1975) noted a shift in the typical dominant species of molluscs and crustaceans to polychaetes in both the sand and transitional areas near the industrial discharges of American Cyanamid and Air Products and Chemicals, Inc. This shift was the result of alteration in sediment granulometry (i.e., deposition of finer grained material), higher organic inputs, and toxic effects.

A more time-effeicient method of assessing benthic community structure has been developed and recently tested within the Pensacola Bay system. The system called REMOTS combines sediment profile photocopy with computer image analysis (Science Application International Corporation, 1986). The system can provide information on sediment grain size and other physical characteristics, as well as biological features of the bottom. The attractiveness of the system is the rapidity of data collection data and interpretation over conventional benthic sampling techniques (weeks vs months). The developers of the system have devised an index with which to characterized an area's sediment quality. It can detect artificial perturbations and recovery from disturbances.

The REMOTS system was used from November 8-10, 1985, primarily within the Pensacola Bay Proper. The areas demonstrated pollution effects: the downtown/Port area and outside Bayou Chico. Anthropogenic organic-loading was suggested as the cause of the situation.

1.8 Bayou-specific Problems

A number of bayous surround the Pensacola Bay system and play an important role in the overall functioning of the system. For instance, many fish species utilize the bayous as nursery grounds. Bayous are fundamentally different from the open waters of the bays. Bayous tend to be very shallow and generally experience a very low tidal range, very low river input, small fetch (i.e., wind mixing), deep anoxic pockets, and constrictions at their entrances. All of these factors combine to accentuate poor water quality conditions and very low flushing capabilities. The isolated arms of the bayous are even more sensitive to any artificial inputs or alterations.

Bayous are complex systems that are comprised of a series of channels, canals, tidal creeks, and marshes. They essentially represent drowned river valleys whose slopes have been altered by a rising sea level.

Mixing in bayous is limited. Some mixing occurs during rainfall events when large amounts of water are discharged into the bayou from suburban areas immediately surrounding them. In the absence of rain events, the dominant mixing process is tidal flux. Because of the narrow mouths, diurnal tides, and a small vertical variation in tidal range, tidal mixing in the bayous is not great. With their unique physical conditions and attractiveness, bayous pose special problems for management.

a. Individual Bayou Discussion

Two bayous have been examined in some detail within the Pensacola Bay system: Mulatto Bayou and Bayou Chico.

Mulatto Bayou.

Mulatto Bayou was the center of a number of fish kills in the early 1970's. Livingston et al. (1972) examined various parameters to discover which factors were responsible for the kills. They found that dredging activities and physical alterations of the bayou combined with the seasonal effects of eutrophication to cause massive fish kills (largely menhaden). Various factors such as temperature, salinity, nutrient availability, current structure, primary productivity, and the presence of large populations of planktivorous (i.e., plankton-eating) fishes, all combined to produce a temporal series of diurnal oxygen variations that ultimately became lethal to portions of the fauna.

The environmental conditions in the bayou appeared closely linked to artificial alterations due to the construction of I-10 (i.e., channelization, borrow pits, and dredging/filling). Dredging and filling activities strongly influenced circulation patterns and water quality within the bayou (Livingston et al., 1972; Olinger et al., 1975).

The fish kills were the result of a timed sequence of interrelated events (both diurnal and seasonal) that showed considerable variation over short and long periods of time. Diurnally, the DO levels demonstrated supersaturation by day and low levels at night. Livingston (1977) postulated that the respiration of the abundant menhaden affected the overall oxygen budget causing already low concentrations at night to fall below the critical level for the support of life.

DER (Interdepartmental Memo, 1970) identified 48 fish species from Mulatto Bayou. Nearly half of these were represented by larval and juvenile stages. The four most dominant were Gulf menhaden (Brevoorita patronus), mullet (Mugil cephalus), spot (Leiostomus xanthurus), and Atlantic croaker (Micropogonias undulatus). In addition, large numbers of small (10-20 mm) blue crabs and penaeid shrimp (Penaeus aztecus) (20-40 mm) were present at various times of the year.

Bayou Chico.

Bayou Chico was singled out in the Escambia/Santa Rosa Counties Resource Management Plan as an integral part of the Pensacola system and would "occupy a place of special consideration in the preparation of the Bay Area Resource Inventory Program."

The drainage pattern within the bayou's watershed has probably been altered significantly due to the extensive urbanization in the region. Water depth in the bayou is shallow with most areas less than 2 m deep. Greater depths are present in the dredged channel and the maximum depth of 6.7 m was located west of Barrancas Ave near the north bank. A railroad trestle and the Barrancas Ave bridge constrict the bayou (to approximately 50 m wide) about 350 m from its opening into Pensacola Bay. Tidal mixing is further reduced inland by the St. Louis - San Francisco Line RR trestle and highway bridge.

Glassen (1977) reported diverse land uses around the bayou. Along the upper sections of the bayou, residential use predominated while in the mid portions, commercial, and industrial uses existed with oil transfer and storage facilities, marinas, shipyards, scrap metal yards, and chemical treatment plants present.

As of 1977, three sewage treatment plants discharged into the bayou. Warrington STP (2.0 mgd design capacity) and Moreno Courts STP (0.21 mgd) discharged into Jones Swamp Creek just above the bayou. The Pen Haven STP discharged into the west end of the bayou's north arm.

Urban stormwater runoff enters the bayou throughout the area and especially at the culvert in the east portion of the north arm (Glassen, 1977). In addition, nonpoint source pollution enters the bayou as runoff from oil terminals, ship repair facilities, and residential areas. Accidental oil spills probably occur during the normal course of industrial activities.

Glassen (1977) reported the trace metal concentrations in the bayou sediments; only iron, zinc, and lead were higher than normal. Areas where runoff entered the bayou also demonstrated high levels of nickel and lead. Oil, grease, and hydrocarbons were found in high concentrations in the upper layers of the sediment.

The upper portions of the bayou demonstrated high nutrient levels (Glassen, 1977). These may have resulted from remineralization of organic matter or inputs of nitrogen and phosphorus from sewage treatment plants and urban runoff such as lawn fertilizers. The lower bayou contained lower nutrient levels and were nitrogen limited relative to phosphorus concentration. Glassen (1977) reported that the sediments in the bayou were toxic and that phytoplankton blooms were most likely caused by exogenous inputs of nutrients from sewage treatment plants, urban runoff, and other sources. Microbial analyses revealed spatial variations that were probably the result of localized effects from point source discharges or local inputs.

Like Mulatto Bayou, Bayou Chico experienced fish kills during the 1970's (DER, 1979). Contributing factors appeared to be seasonal increases in water temperature, excess levels of nutrients, poor water circulation, and algal blooms. Night-time depletions of DO were also critical.

1.9 Shoreline Erosion and Alteration

Several reports (e.g., University of Florida, 1977; Olsen, 1984) have noted that the north shore of Santa Rosa Island has experienced erosional problems, especially during the winter months when northerly winds drive erosive waves across the Sound. The situation appears to be the result of a natural rise in sea level and the presence of man-made structures (e.g., bridges, docks, and bulkheads) that obstruct the littoral transport along the shoreline. Along the soundside of Santa Rosa Island at Pensacola Beach, property owners have used bulkheads, in particular, as an erosional deterent device. In addition, since the early 1900's the Intracoastal Waterway has been dredged along the entire length of the soundside shorelines.

It is important to note that a primary source of sediment for the sound shorelines comes from the breaching of the barrier island by storms that transport quantities of sediment to the shoreline. The presence of large spits, in particular "Sharp Point" and "Range Point", may represent washover fans as a result of storm activity. There are also many small spits that are present.

Development in some areas of the shoreline dates from the late 1940's and early 1950's and includes single-family residences, multi-family dwellings, and some commercial facilities. However, it was only in 1973 that setbacks from the MHWL (mean high water line) were required. Olsen (1984) divided the area into four separate classifications based upon man-made impacts. He subsequently made recommendations for shoreline structures for each of the four regions.

Shoreline erosion has been reported for the Gulf beaches of Santa Rosa Island and Perdido Key. Long-term trends have been erosional along the area over the past 100 yrs (Stone, 1984c). Perdido Key has retreated landward at an average rate of 0.6 m/yr (1858-1974). Santa Rosa Island shows approximately the same rate 0.5 m/yr (1856-1965). Exposed peat deposits have been located along areas in the nearshore, thus implying rollover of both barriers. Short-term shoreline trends are also erosional. Rates are extremely variable, averaging 9 m/yr along some sections of Perdido Key (1974-1981) and 3 m/yr along Santa Rosa Island (1974-1981) (note: 2 hurricanes affected these statistics). Hurricanes and accompanying storm wave conditions have caused significant changes in the morphology of the study area - for this reason shoreline response must be evaluated and considered in coastal management (Stone, 1984c).

The position of Pensacola Pass has been determined by the historical migration of Santa Rosa Island and Perdido Key. In this sense, the pass formed "naturally" and not as a consequence of, for example, energy wave breaching or dredging. Continual dredging is required to ensure navigitable water depths (10.6 m) and entrance channel widths (152.4 m).

There has been a complex of mechanisms involving periods of migratory reversals in the two barriers. The sequence of events was as follows (Stone, 1984c):

1) 1780-1856 - a westward growth of Santa Rosa Island and eastward migration of Perdido Key (rates not determinable because of questionable accuracy of maps).

2) 1856-1931 - a westward movement of Santa Rosa Island for a linear distance of 686 m +/- 4 m or 9 m/yr; increase in surface area by approximately 662,000 m^2. Westward migration of Perdido Key of 126 m +/- 4 m, i.e., rate of 2 m/yr.

3) 1931-1962 - a linear migration of Santa Rosa Island, from east to west of 364 m +/- 4 m, i.e., rate of 11 m/yr. Increase in surface area of western Santa Rosa Island by ca. 656,000 m^2 (21,000 m^2/yr), rate of increase was greater than from 1856-1931 because of placement of dredge disposal (ca. 418,000 m^2) on western end of island. Perdido Key migrated east for a distance of 69 m +/- 4 m, i.e., rate of 2 m/yr.

4) 1962-1971 - decrease in surface area of western Santa Rosa Island by ca. 156,000 m^2 +/- 4 m, i.e., 17,000 m^2/yr, no apparent linear migration. Perdidio Key migrated 40 m +/- 4 m to east, i.e., 4.4 m/yr.

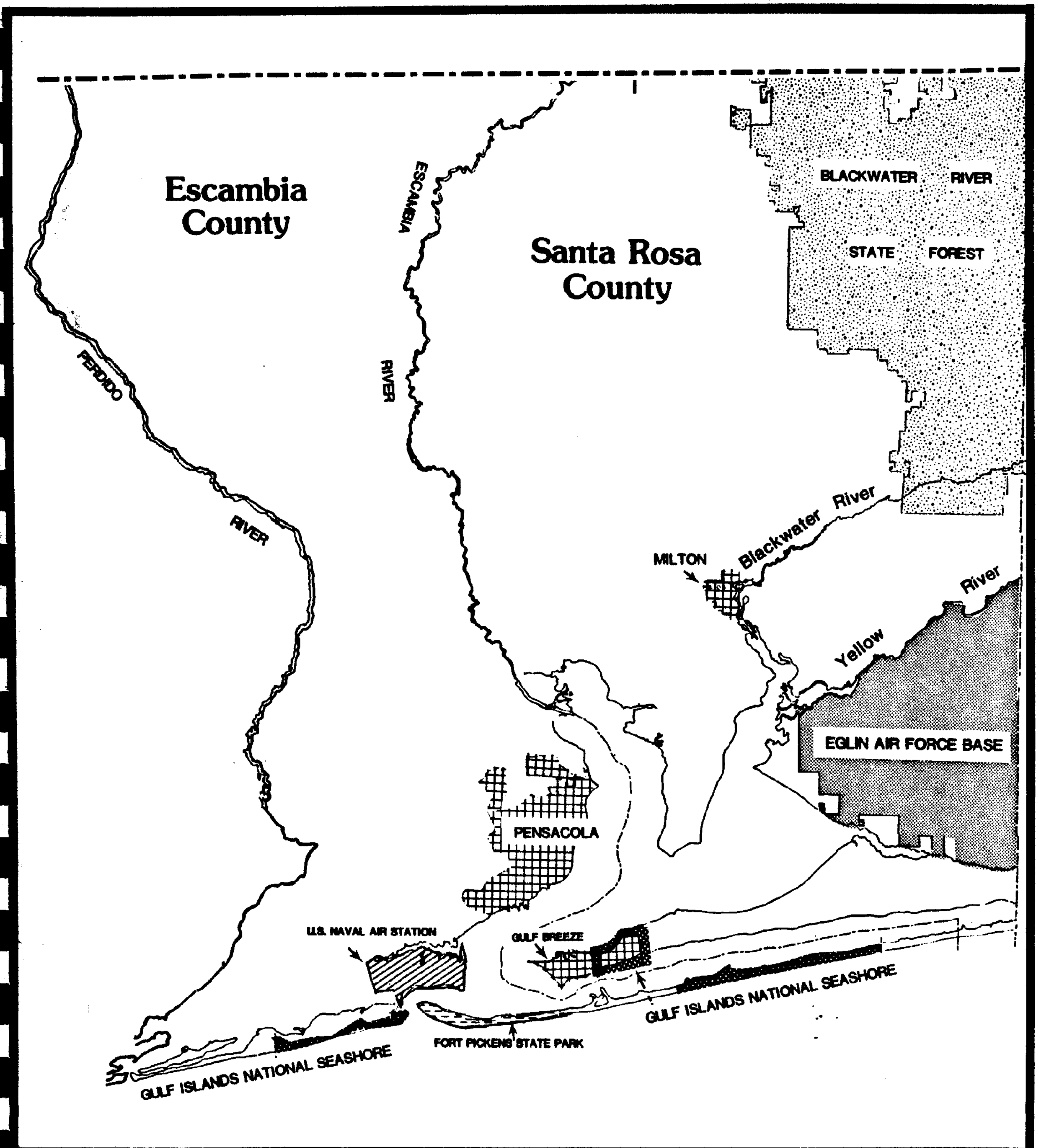
5) 1971-1981 - decrease in surface area of Santa Rosa Island by ca. 164,000 m^2 +/- 4 m, i.e., 16,000 m^2/yr, migration from west to east by approximately 100 m (10 m/yr). Perdido Key showed slight movement to east back to its 1856 shoreline positions.

The data suggest that the western extremity of Santa Rosa Island has, since 1962, remained relatively stable in space and exhibited only slight movement to east. Analysis and comparison of 1981-1984 aerial photos suggest that the western tip of Santa Rosa Island has continued to migrate to east by an average distance of 30 m (Stone, 1984c).

Perdido Key has continued to migrate towards the east for the last 50 years. Since 1962, this movement has occurred at a greater rate than that measured along western Santa Rosa Island. From this trend, it becomes apparent that the eastward movement of sediment along Perdido Key is significant even though many have thought not. A likely source of sediment is immediately west along Perdido Key where island shows to be decreasing in width at a rate of 2 - 8 m/yr.

There has been recent consideration by the US Army Corp of Engineers and the National Park Service on depositing dredge material along an eroding section of Perdido Key approximately 1 km west of the Pass. As noted earlier, the entrance channel to Pensacola Pass requires periodic dredging to ensure navigatible water depth. Stone (1984c) has shown that sediment is directed east. At the proposed spoil deposition site along eastern Perdido Key into Pensacola Pass during 120, 60, and 45° deep water wave approaches (note: the phenomenon is due to wave refraction). More material would enter the shoal and channel system if the dredged material was deposited at the proposed site. The morphology of eastern Perdido Key and western Santa Rosa Island is linked tightly to wave processes in operation along the area. Depending on the angle of wave strike to the beach, sediment transport will differ.

Stone (1984c) reported results that indicated complex nearshore cell circulation patterns on the Gulf side of the Navarre area, not previously recognized. Results also illustrate changes in this circulation system if there is jetty and channel construction. Evidence now suggests that sediment is not transported in one direction in a "river of sand" fashion - as previously envisioned during any particular wave climate condition - but that transportation fluctuates in a complex fashion. However, the dominant, annual net movement of sediment is from east to west along Santa Rosa Island.



Section-2 Jurisdictional & Regulatory Framework

Section 2. Jurisdictional and Regulatory Framework during Study Period

2.1 Introduction

The scope of this section comprises those land use practices carried out at all government levels in Escambia and Santa Rosa Counties. The analysis focuses on the jurisdictions which oversee activities along the coast and rivers of the two counties. The agencies examined are those whose role has a direct bearing on water quality in the estuarine system. The following are included:

Federal

U.S. Army Corps of Engineers
Environmental Protection Agency
U.S. Fish and Wildlife Service
National Marine Fisheries Service
U.S. Department of Agriculture
U.S. Naval Air Station (Pensacola)
U.S. Air Force Base (Eglin)
Federal Emergency Management Agency

State

Department of Agriculture and Consumer Services
Department of Community Affairs
Department of Environmental Regulation
Department of Health and Rehabilitative Services
Department of Natural Resources
Game and Freshwater Fish Commission
Marine Fisheries Commission
University of West Florida

Regional

Northwest Florida Water Management District
West Florida Regional Planning Council
Escambia/Santa Rosa Coast Resource Planning and Management Committee

Local

Escambia County
- Board of County Commissioners
- Escambia County Utilities Board
- Soil and Water Conservation District

Santa Rosa Island Authority

Santa Rosa County
- Board of County Commissioners
- Health Department
- Soil and Water Conservation District
- South Santa Rosa County Utilities Board
  - Midway Water System Franchise
  - Holley-Navarre System Franchise
  - Santa Rosa Shores, Inc.
  - Navarre Beach Administrative Board

City of Pensacola

City of Gulf Breeze

City of Milton

Agency involvement can be described under four separate categories.

1) Regulation/Enforcement - By statute or ordinance, an agency has the authority to issue a permit and or veto a project or activity.

2) Planning/Policy Development - Through statute, ordinance, executive directive, or explicit local policy, the agency will establish goals, set guidelines, and develop implementation strategies for activities or projects.

3) Review/Advisory - By statute, ordinance, executive directive, or explicit local policy, an agency is required to be aware of a project or activity and make recommendations or comments.

4) Research/Education - Agencies are called on for data collection or interpretation. This information can be used to establish a public awareness of critical issues.

All four categories are essential steps toward improving conditions in the estuarine system.

Specific categories of regulations are useful in isolating factors which influence the Pensacola Bay estuarine system. Pertinent to this study are regulations which manage, control, or restrict point and non-point sources of pollution. The measures which deal with pollutants in the system include zoning and subdivision requirements, restrictive covenants, wastewater treatment, stormwater management, dredge and fill provisions, sediment and erosion control, shoreline protection, and capital improvement programming. Implementation and oversight of these measures occurs in many forms and on many levels. Permitting, public grants/appropriations, site plan review, building certification, and public acquisition are some examples. The discussion spans the same period in which the marine research data was collected, from the 1950's to the present.

2.2 Land use practices since the 1950's - a summary

The Federal Government

Federal involvement in estuarine management and attendant water quality issues includes regulatory, advisory, and education activities. The Fish and Wildlife Act of 1956 established policy for the development of commercial fisheries and promoted the consumption of fish. The Fish Restoration and Management Projects Act and the Sport Fish Restoration Act provided financial assistance for the conservation of game fish and wildlife. Their policies were carried forward by the Coastal Zone Management Act of 1972. This act, moreover, authorizes the Secretary of Commerce to award grants to allow states to develop coastal management programs. These programs are designed to preserve, protect, develop, and restore or enhance the resources of the nation's coastal zone for present and future needs. The Endangered Species Act of 1973 is another well-known conservation measure. The federal government targeted several specific conservation activities with the Estuary Protection Act (19date). The federal government also initiated dune protection locally by establishing the Gulf Islands National Seashore.

The Federal Water Pollution Control Act of 1965 and the National Environmental Policy Act of 1969 became the most critical areas of environmental quality in federal regulation. Water quality impacts and standards for pollution levels in navigable waters adopted in these laws have been an essential component of estuarine management in the study area. States were required to comply with a set of minimum water quality standards for all bodies of water within its borders. Maximum discharges for various pollutants were determined and permits issued specifying the quantity of wastes each discharger could legally discharge. These controls were primarily directed toward industrial and municipal sources of pollution.

Federal Water Pollution Control Act amendments in 1972 and 1977 established a system of technology-based effluent standards. Non-point sources were not covered by these standards, yet the legislation established the concept of controlling water pollution from all sources based on planning by geographic areas.

Other environmental quality enactments include the Resource Recovery Act and the Federal Insecticide, Fungicide and Rodenticide Act, intended to prevent indiscriminate pesticide application as a stormwater precaution. Fertilizer runoff is monitored and regulated in the Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System. The Oil Pollution Act of 1961 has been dealing with the most deliberate discharges or negligent practices of vessels within fifty miles

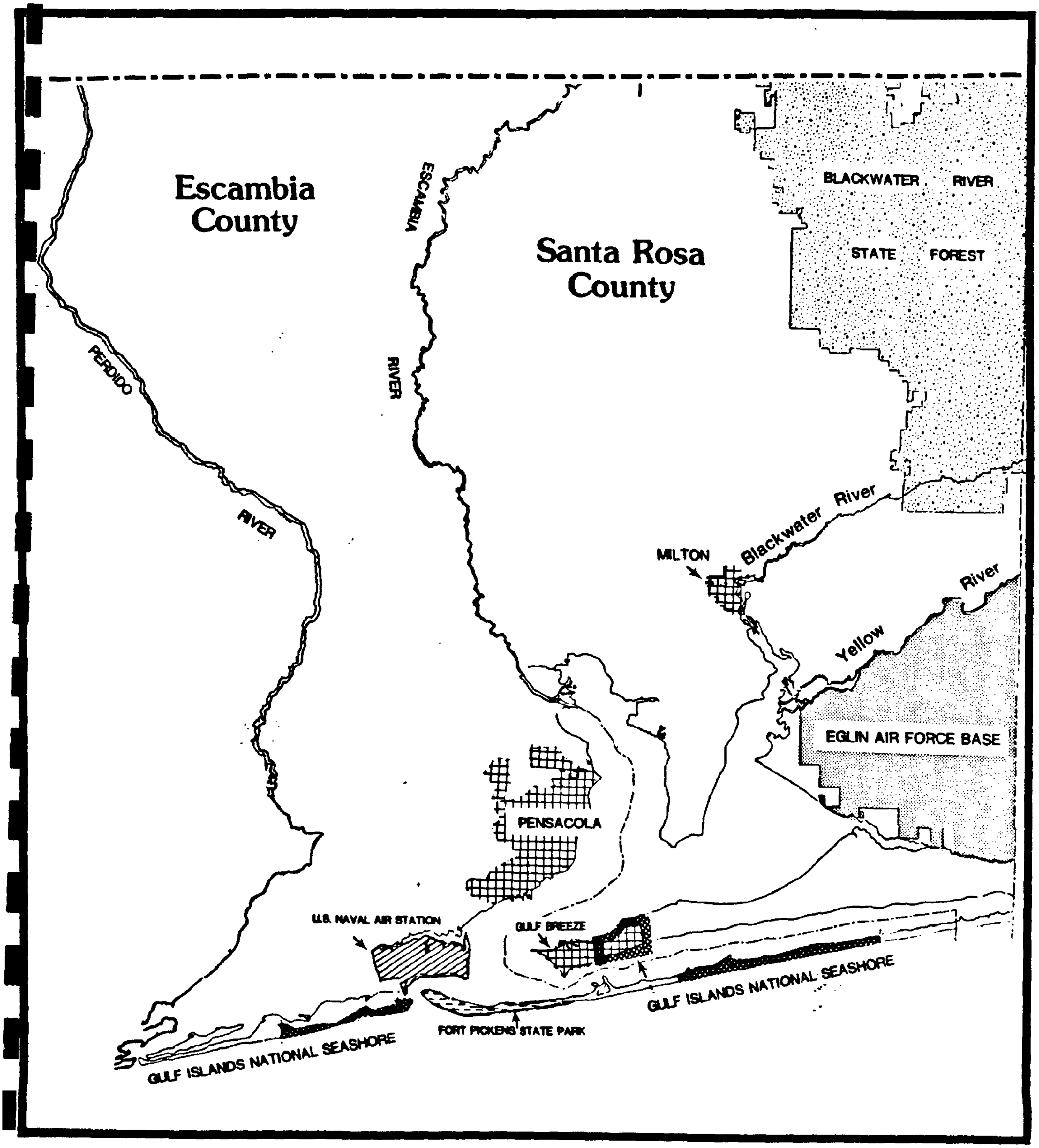


Figure 2.1 Political divisions (jurisdictions).

of the shore.

The Army Corps of Engineers (ACOE) regulates dredging and filling pursuant to the River and Harbor Act of 1899, and the Clean Water Act of 1972. The Marine Protection Act (1972) authorizes the ACOE to issue permits for transportation and dumping of dredged spoil materials in ocean waters. The Marine Sanctuaries Act of 1972 authorizes the Secretary of Commerce to designate certain areas as marine sanctuaries offering protection to estuaries and their adjoining land areas.

Many of the above federal programs were not necessarily mindful of the political and economic realities of the study area. Some programs were not structured to administer to emerging critical needs, thereby rendering some goals as wholly unattainable. For example, the EPA was to achieve the goal of no pollution by 1985. Nevertheless, as coordination with state and local has increased, and standards have been more widely recognized, the federal government's role in the Pensacola Bay area has been more meaningful.

The State of Florida

State ownership of navigable waterways is established under the Florida Constitution, Article X, Subsection 11. All title to lands under navigable waters, including beaches, up to the mean high water mark is held by the State in trust for the people. Private use of these lands may be authorized by law if not contrary to the public interest.

The myriad of programs authorized to review and permit activities affecting coastal management has made the system in Florida very complex. The Environmental Reorganization Act of 1975 dealt with some of the system's major problems.

The Act created the Department of Environmental Regulation (DER), the agency with primary responsibility for environmental permitting. Under Chapter 253, Florida Statutes, all the powers, duties, and functions of the Department of Natural Resources pertaining to permits, licenses, and exemptions were transferred to DER. As a result, dredge and fill activities have been subject to established water quality standards. Pursuant to the Florida Air and Water Pollution Control Act, Chapter 403, Florida Statutes, DER regulates: water quality standards, permits, domestic and waste treatment requirements, resource recovery and management, sewage disposal facilities, industrial siting, stormwater, and hazardous waste.

The Outstanding Florida Waters (OFW) program, encompasses those water bodies which are to receive the highest protection from DER. The program includes the following areas within the study area:

Waters within State Parks or Recreation Areas -
Blackwater River State Park

Waters within National Seashores -
Gulf Islands National Seashore

Waters within State Aquatic Preserves -
Yellow River Marsh
Fort Pickens State Park

Special Waters -
Blackwater River

The Northwest Florida Water Management District was established under Chapter 373, Florida Statutes in 1980. The purpose of the District, which also includes other North Florida counties, is to assure that activities relating to the management and storage of surface waters will not be harmful to the water resources and will provide for the safety of life and property within the District. It is the only water management district in Florida which is tightly restricted in the revenue that it can raise. This limits any active role that it could have in resource management.

The Department of Natural Resources (DNR) is authorized to lease, regulate, and permit activities in sovereignty submerged lands, under Chapter 253, Florida Statutes. DNR selects and acquires property for the state under the Conservation and Recreation Lands (CARL), rule and the State Land Acquisition Procedures rule. The Florida Aquatic Preserves program which preserves exceptional areas of sovereignty lands, Chapter 258, Florida Statutes oversees management of the Fort Pickens State Park Preserve in Escambia County and the Yellow River Marsh in Santa Rosa County. These areas are subject to marina siting requirements, among other management criteria. Chapter 161 and 370, Florida Statutes are implemented rules and procedures for coastal construction and excavation seaward of the coastal construction control line and the thirty erosion setback line. Chapter 376, Florida Statutes authorized DNR with enforcement actions for violations against the Pollutant Discharge Act of 1974.

The Department of Health and Rehabilitative Services administers standards for onsite sewage disposal systems from authority granted under Chapter 373, Florida Statutes, through the rule Chapter 10D.

The Environmental Land and Water Management Act, Chapter

380, Florida Statutes, authorizes the Department of Community Affairs (DCA) to administer two programs which review land use procedures in the study area. The Areas of Critical State Concern program was the basis for establishing the Escambia/Santa Rosa Coast Resource Planning and Management Committee. The Committee was set up to help southern Escambia and Santa Rosa Counties guide growth, by developing the Resource Management Plan in 1985. The Developments of Regional Impact (DRI) program has designed a review procedure for developments that, due to the nature, magnitude or location will have a substantial impact on more than one county. Chapter 27F, Florida Administrative Code sets guidlines and thresholds by which to evaluate whether a development project is a DRI.

DCA has also been the agency responsible for administering the Local Government Comprehensive Planning Act, Chapter 163, Florida Statutes. The statute was amended in 1985 as the Local Government Comprehensive Planning and Land Development Regulations Act. Prior to these amendments DCA was involved mainly in an advisory capacity as it reviewed local governments' compliance with general guidelines. The recent amendments direct DCA to adopt minimum criteria for comprehensive plans with which the local governments must comply. A coastal management element also is required in each coastal local government's comprehensive plan.

The Game and Freshwater Fish Commission manages wild animal life and freshwater aquatic life over public or private lands. The authority to implement this agency's rules came from Chapter 372, Florida Statutes.

The Department of Agriculture and Consumer Services is authorized under Chapter Chapter 487, Florida Statutes to administer the registration and the use of pesticides and fertilizers. Chapter 582 authorizes the Department to administer federal soil and water conservation programs.

Local Governments

The local governments are the areas of greatest concern as they are the most immediate level overseeing activities which have affected water quality decline, habitat destruction, shoreline protection, and erosion and sediment control. Those local governments within this reports study area are faced with the daily administrative challenge of contending with tremendous growth pressure.

Escambia County

This jurisdiction has a sparse history of land use regulations. In 1947, the Legislature created the Santa Rosa Island Authority, (Chapter 24500, Laws of Florida) vesting that same entity with broad powers, delegated through the County Commission, to include the maintainence and development of Santa Rosa Island structures. At that time, the Santa Rosa Island Development Code was adopted. This code was revised in 1970, 1973, and 1979 to become a meaningful land use regulation, providing local control for important natural resources. Section III, the most comprehensive part, deals especially with fills, bulkheads, docks, marinas, canals, and beach management. Design standards for waterfront locations, drainage easement provisions, requirements for open space dedications and sewage service are also included.

<u>County Ordinance Number 86-7</u>

Escambia County adopted for the University of West Florida vicinity a set of land use regulations in 1966. These were revised in 1971 and amended in 1973 and 1986. The area affected is north of Pensacola proper and bordering on the northwest shore of Escambia Bay. This set of regulations is one of a very few comprehensive land use controls in Escambia County. The 1986 "Comprehensive Amendment" contains a land use map dated from 1973.

<u>County Ordinance Number 85-46</u>

The other comprehensive set of regulations was adopted by a zoning ordinance for Perdido Key in 1983. It was repealed and replaced by ordinances adopted in 1984 and 1985. This ordinance contains a future land use map revised in 1983. Both Ordinances 85-46 and 86-7 specify an estuarine setback in which no new major construction is permitted, between the Mean Sea Level as established by the National Geodedic Survey Datum and an elevation of (+)2.5 feet along the two areas respective shorelines.

<u>Subdivision Ordinance 85-21</u>

The remainder of unincorporated Escambia County is regulated by the use of subdivision ordinances which first were adopted in 1973. Prior to that, private land use controls such as restrictive covenants were the only measure used. The original ordinance was amended in 1975, 1979, 1981, and 1983 and repealed in 1985.

<u>Drainage Ordinance 73-10</u>

This law, only slightly amended in 1983, is aimed at reducing off-site drainage and water pollution. It demonstrates concern for stormwater runoff by allowing up to 100 percent of impervious surface only upon evidence that the additional percentage will not deteriorate water quality or contribute to off-site drainage problems. It applies to all manufacturing, industrial, and commercial buildings, and to residential uses with more than twelve units.

<u>Lot Coverage Ordinance 85-29</u>
This ordinance established standards relating to lot coverage when it first was adopted in 1983. Instead of the absolute percentage of impervious surface permitted for each development as set up in the earlier subdivision ordinances, this provided a formula in which to determine drainage.

<u>Sediment Control Ordinance 85-32</u>
This ordinance first established standards in 1974 for the amount of allowable sediment in stormwater runoff. It also required the use of sediment control structures. This and subsequent amendments adopted in 1977, 1978, and 1984 were repealed and replaced by the Ordinance 85-32 to reflect the changes made in Escambia County's Subdivision Ordinance.

<u>Coastal Hazard Prevention and Protection Ordinance 75-3</u>
This ordinance established requirements for structures to guard against 100 year floods. The intent was to provide for no obstruction of the flow of flood waters, minimize damage and regulate the manner and type of construction, particularly that below and just above flood levels. A portion specifically addresses filling in flood-prone lands. Agricultural uses and construction under 1,000 square feet are exempt.

<u>Special Flood Hazard Ordinance 85-19</u>
Originally adopted in 1977, this ordinance establishes areas of special flood hazard within Escambia County. It also sets standards and requirements for construction and other activities on lands within the areas of special flood hazard. Maps of the affected areas are adopted along with the ordinance.

At this writing Escambia County is preparing a land use ordinance which includes a zoning program. Since it is in the review stage, it is premature to comment on the ordinances features.

The Escambia County Board of Commissioners adopted its most recent Comprehensive Plan in 1980. All unicorporated areas, including Perdido Key and the Santa Rosa Island Authority are subject to this plan. Many of the Plan's policies have been analyzed in depth by the Escambia/Santa Rosa Coastal Resource Planning and Management Committee. This review focuses on how the Plan's policies address the water quality of the Pensacola Bay area. Those elements in the Plan that set policies which affect estuarine water quality include: Land Use and Growth; Conservation; Coastal Protection; Recreation and Open Space; and Sanitary Sewer, Solid Waste, Drainage, and Potable Water.

The Land and Growth Element encourages the following

policies:
o residential development in areas and on soils and topography suitable for such use,
o new industries to locate in suitable areas served by utilities and transportation facilities,
o the retention of agricultural and forest land, and recommends that a County Land Use Ordinance be consistent with the values of area residents and is based upon the concept of private property and public interest.

This element contains a future land use map which uses crude land use classifications: urban (15-25 dwelling units per acre), transition (5-14 dwelling units per acre), and rural-agricultural (0-4 dwelling units per acre). These classifications do not consider the variation of suitability of land for different types of development. The classification and density seem to be a function of the land's proximity to the City of Pensacola and to the coast. In the absense of zoning, this general kind of mapping does not consider that certain areas require greater protection than other areas. In this sense, the future land use map fails to offer any strategic plans as to where growth can be sensibly directed with minimal impacts on the estuarine system.

The Conservation Element in the Plan includes the following policies:
o discourage the location of inappropriate residential, commercial, and industrial land uses or other developments in floodplains or westlands;
o encourage the conservation of wetlands and floodplains as water quality control, natural recreation areas, and storm buffers.
o place land use restrictions on all land areas identified as Conservation Areas in order to regulate and control adverse effects resulting from urban development.

Most of the areas which require special protection in the policies listed above are mapped in other documents. The Conservation Area, however, is a designation unique to Escambia County. Neither has it been incorporated into the text, nor is there a reference to where it can be obtained. This omission makes it very difficult to carry out an important policy.

The Coastal Protection Element is the most crucial portion of the Plan in that its central function is to assure that activities along the coastline have a minimal impact upon the marine ecology. The policies include:
o adequate natural vegetated buffer zones shall be maintained between mean high water and proposed improvements, developments, land alterations, projects or structures, unless such will unduly restrict the use of private property.

o maintain and protect the primary dune systems and the vegetation associated with marshes and wetlands on the barrier islands.

o the marshes and marine grass beds of the coastal zone are considered vital to the maintenance and protection of the coastal and economic resources of Escambia County, and as such, developments which would degrade or minimize the natural productive capacity of such areas are discouraged.

o the natural drainage patterns shall be maintained and protected to the maximum extent feasible, consistent with the need to protect the environment and to provide adequate deposition of stormwater runoff.

o adequate vegetated buffers along drainageways shall be maintained to the maximum extent feasible, consistent with private property rights.

o activities or developments which cause or allow saltwater intrusion into the freshwater lens of the barrier islands are prohibited except as authorized through special review processes.

o dredging, filling, or activities artificially lowering the water table of the barrier islands are prohibited except as authorized through special review.

The force of these policies is undermined by qualifying language which concedes additional discretion in the use of private property. Under the Plan, protection of coastal resources is advised, however, not at the expense of private property rights. Estuarine setback requirements advocated in this element for Perdido Key are measures that would be well advised for all coastal areas in the County.

The Recreation and Open Space Element is an appropriate place in which to reinforce and supplement the measures advocated in the coastal protection and land use elements. Sensitive areas along the rivers and coast could be the prime focus of an open space program. Open space designation is attainable because it can be established through means other than fee simple land acquisition. Affordable means such as conservation easements over portions of private property would establish many open spaces along areas that require additional protection. This opportunity, however, is lost in the existing element whose policies do not address the function of protection in either a recreational or an open space program. Policies that recognize more diverse functions of recreation and open space should be incorporated into the Plan.

The Sanitary Sewer, Solid Waste, Drainage, and Potable Water Element emphasizes the need for coordination throughout the policies for each category:

o coordinate efforts of Escambia County with those of the City of Pensacola and other communities in their provision of sewerage to their respective service areas.

o support the construction of sewerage facilities for the Cantonment and Century areas.

o develop an area solid waste disposal plan for Escambia County.

o coordinate Escambia County's solid waste efforts and plans with those of adjacent communities.

o establish a solid waste disposal tipping fee or user charge capable of supporting all allowable and allocable costs of solid waste operations including acquisition of equipment, depreciation, and debt retirement.

o encourage mandatory residential solid waste collection for the southern portion of Escambia County.

o utilize natural drainageways for stormwater runoff whenever possible.

o control stormwater through onsite development of structures designed to minimize peak stormwater flow consistent with the County Master Drainage Plan when adopted.

o Coordinate plans for stormwater management with other regional and local plans for transportion, open space, solid waste disposal and land use.

o establish a floodplain management program for Escambia County consistent with the Southwest Escambia County Master Drainage Plan when adopted and implemented.

o encourage cooperation and coordination among public water suppliers in order to provide the most efficient system of potable water supply.

o require public water suppliers to prepare emergency and contingency plans in case power, equipment, or resource failure.

o protect those recharge areas necessary for the maintenance of the supply of potable water.

o insure continued potable water availablity by preventing excessive withdrawals, particularly in areas of known and suspected saltwater encroachment.

o cooperate and coordinate efforts of the Escambia County Health Department and other concerned County departments with those of the Northwest Florida Water Management District in providing, conserving, and maintainning the quality of potable water.

Since this element pertains to capital improvements which affect more than one jurisdiction, coordination is well advised. The extent to which these policies address protection of the resourcea that the services manage or maintain is marginal. Other than the specific reference to the Cantonment and Century Service areas requiring sewerage facilities, no priorities have been assigned to improve the delivery of service in sensitive areas along the rivers or the coast. Since many of the sensitive areas are also those which are dealing with a great deal of growth pressure, the policies should reflect that special areas exist which require critical attention.

City of Pensacola

This city has the longest standing history of zoning regulations of all the local governments within the study area. In 1947 it passed Zoning Ordinance 9-47. A typical Euclidean zoning scheme, it established districts and boundaries for residential, commercial, and industrial uses. This ordinance and its subsequent amendments in 1965, 1970, and 1986 contain land use district maps which show progressively more intense uses zoned adjacent to the estuarine system, especially along Bayou Chico and nearby Pensacola Bay.

A large part of the eastern boundary of the city, however, is zoned as a special district known as the Escambia Bay Bluffs and Shoreline District, which requires greater attention to site planning and aesthetics with emphasis on retention of natural topographical features and vegetation and preservation of open space. Even as the Land Development Code of 1986 consolidated all land use ordinances and their amendments, only a few special land use districts like the Escambia Bay Bluffs and the Bayou Texar Shoreline Districts have specified performance standards.

The Code's Open Space District also retains sound estuarine management practices. This district is to establish and preserve open space areas necessary for protecting water resources, providing parklands and wilderness reserves, conserving endemic vegetation, and preventing flood damage and soil erosion. Unlike Escambia County's Open Space Element, this measure more vividly associates the functions of an open space program with protecting the estuarine system.

In addition to zoning, Pensacola's Land Development Code addresses tree and landscape regulations; subdivisions; erosion, sedimentation, and runoff control; and floodplain management. The tree and landscape provisions, stemming from a 1975 ordinance, are detailed and offer a good deal of protection. The buffer concept could be more ambitious, especially where the coastline is concerned. A ten foot strip is not enough to curb erosion and stormwater runoff. The enforcement provisions are very clear.

The subdivision section originated from the 1956 Subdivision Ordinance. Plats are required for a building permit. Adequate drainage and street layout are the principal considerations for plat approval. Structural provisions are tied closely to direction given in the Comprehensive Plan.

The 1975 Erosion Control and Runoff Ordinance also was incorporated into Pensacola's Land Development Code. Design standards require comprehensive drainage plans based upon a 25 year flood, for any construction activity. A great deal of discretion is granted to the City Engineer in waiving the requirements.

Of final interest to estuarine management within the Land Development Code, is the Flood Plain Management Chapter. It incorporates federal and state flood hazard provisions into one local law. Originally this chapter was adopted as an ordinance in 1977.

Chapter 4-3 of the Municipal Code deals with the regulation of solid waste disposal, including hazardous waste. One section specifically requires that industrial wastes be disposed of by appropriate, non-detrimental means. These sanitation regulations were designed to restrict harmful effects upon the upland as well as all waters. Although the Public Service Department official has had the authority to examine all premises to determine their sanitary condition, implementation was observed in the early Seventies as ineffective.

Chapter 135 regulates users of sewage systems. The city may reject wastes or require pre-treatment, control, or payment for treatment. Developers are required to provide basically all of the essential facilities. These improvements eventually become the property of the city and may be used by the general public. A special section prohibits the use of sewers for stormwater; and untreated drainage; unpolluted industrial process water; numerous solid, corrosive, toxic, and poisonous substances which have been compiled. Ph levels and temperature restrictions also are listed.

The Pensacola City Council adopted the Pensacola Comprehensive Plan in 1981. The elements in the Plan that set policies that affect estuarine water quality include: Natural Resource Conservation and Coastal Zone Management; General Utility; and Recreation and Open Space. Accompanying the Plan is a useful, detailed land use map.

The Natural Resource Conservation and Coastal Zone Management Element stresses reliance upon and cooperation with all governmental levels in implementing necessary environmental quality regulations. It lists the following policies:

o development shall be compatible with adjacent land and water uses to the maximum extent practical.

o development in areas adjacent to environmentally sensitive areas is to be sited and designed to prevent impacts which should significantly degrade such areas.

o public shoreline recreational uses, areas and facilities and access to such areas should be protected.

This important element would be more useful if more exacting policies were enumerated. The general nature of each policy gives public officials little to rely upon when reviewing and approving any kind of land use activity. More definitive positions on the need for shoreline buffers is one direction where improvements are due.

The General Utility Elements includes several subelements which pertain to estuarine water quality: wastewater, drainage, solid waste, and potable water. Each of these subelements relies upon a separate document for discussions on each topic. Consequently, no policies are submitted in the Plan itself. Some policies should be stated in the Plan to give more direction in these areas, such as was provided in the Escambia County Sanitary Sewer, Solid Waste, Drainage, and Potalbe Water Element.

The Recreation and Open Space Element details a five year program plan with priorities identified. Among several other policies this element lists the following:

o develop parks and facilities in the northeastern section of Pensacola.

o formation of a county-wide recreation and park council which should include cities, county, schools, colleges, and the United Way.

o determine availability of state and federal funds for public recreational activities and facilities.

This element could be more closely associated with shoreline protection as was discussed under Escambia County's Recreation and Open Space Element. Policies that address more diverse functions for recreational and open space programs would improve the chances of accomplishing a greater portion of the Park Program.

A useful element that the Plan lacks is a future land use element in the Long Range Policy and Plan Package III. Without this element the Plan does not address policies which guide future growth. Without this element, there can be no strategic planning as to where growth can sensibly be directed with minimal impacts on the estuarine system.

Santa Rosa County

The other county in this two county estuarine study area is Santa Rosa County. It, like Escambia County, has been guided by few land use regulations over the last thirty years. With the increased growth rate that is occurring along the southern portion of the county, adequate safeguards are essential. The following is a discussion of the ordinances and comprehensive plan policies that govern the unincorporated areas of Santa Rosa County. Following this is a discussion of those measures which govern the cities of Gulf Breeze and Milton.

<u>South Santa Rosa County Zoning Ordinance 86-16</u>

This comprehensive ordinance was adopted as recently as 1986, repealing Ordinance 85-25 Land Use Regulations for South Santa Rosa County. It established land use regulations for only the peninsula east of the City of Gulf Breeze and South of the East Bay River, also known as the South Santa Rosa County Planning Area. The remainder of the unincorporated areas are not subject to any zoning. The performance standards attempt to control "potential nuisances." This type of approach emphasizes aesthetics more than the function of natural systems. It fails as a result to deal effectively with environmental impacts. The zoning maps which accompany this ordinance do not show a buffer along the coastline. A shoreline protection district classification and or a provision within the Planned Unit Development classification assuring strict review of development adjacent to the coast would remedy this ommission.

The Navarre Beach Administrative Board Land Development Code is a set of rules based on the Santa Rosa Island Authority Development Code. It is used to regulate development in the Navarre Beach Community in unicorporated Santa Rosa. Many of the provisions in the code are not applicable to that community's situation. It is currently being revised to assure more meaningful review of land use activity.

<u>Subdivision Ordinance 86-01</u>
This ordinance originated in 1974. It set out plat requirements dealing with detailed contour maps, all easements, and a drainage plan to include storm sewers, coverts, easements, final disposal and outfall ditches. The county amended this ordinance in 1983, 1985, and 1986. In the absence of zoning in most parts of the county, the subdivision ordinance and restrictive covenants are the only local land use regulations.

<u>County Ordinance 72-8</u>
This ordinance was originally adopted in 1972. It required no explicit standards other than for the surveillance of the county land fills and for the permitting and inspection of septic tank installation. Although numerous studies and plans have been done since 1972, there appears to be no amendments adopted to reflect the growing complexity of regulating these services.

<u>Special Flood Hazard Ordinance 85-21</u>
A land management program was established to enable flood-prone communities to be elligible for flood insurance in 1972. Standards were adopted and building permits were required in order to minimize damage due to flood effects. This ordinance was amended in 1974, 1975, 1977, and 1985, reflecting changes in the federal program.

<u>Santa Rosa County Utilities Board Ordinance 86-06</u>
This ordinance provides for future planning services and

plan preparations for utilities development. The Santa Rosa County Utilities Board, whose jurisdictional area is designated under this ordinance, shall oversee planning and operation requirements associated with the provision of area- wide utilities.

To date, no solid waste mangagement ordinance has been adopted. Local officials are studying how such an ordinance should be designed.

The Santa Rosa County Board of Commissioners adopted its Comprehensive Plan in 1982. All unincorporated areas, including Navarre Beach, are subject to this plan. Of the elements listed in the Plan, those applicable to estuarine resouces include Sanitary Sewer, Solid Waste, Drainage, and Potable Water; Utility; Conservation; Coastal Zone; Recreation and Open Space; and Future Land Use. The level of specificity varies with each element.

The first element enumerates policies for Sanitary Sewerage Systems:

o establish a coordinated system of sanitary sewer facilities designed to provide the range and level of services necessary to serve the existing and anticipated population of the County.

o encourage patterns of growth and development that permit the construction of sanitary water facilities and provide for their orderly expansion.

o encourage adequate regulation of individual waste disposal systems.

o implement the 201 Facilities Plan.

The applicable solid waste management policies include:

o continue the provision of collection services to all areas of the County.

o vigorously enforce county ordinances to prohibit litter of public or private lands and waters.

It also lists drainage policies:

o insure that designated natural drainage corridors are maintained in an open and unobstructed condition in order to conserve their function and prevent flooding.

o discourage development practices which give rise to the overdrainage of land and soils.

o require developers of industrial sites, subdivisions and PUD's to provide stormwater retention systems where feasible after engineering studies to minimize flooding and non-point source pollution.

Finally, the element includes policies about potable water supply systems:

o provide water for existing and future populations in the County in ways that are consistent with sound water resources planning.

o encourage new developments that will not aggravate problems in existing public water supply systems.

o encourage local enforcement of established water quality standards.

o establish a water conservation program to prevent aquifer drawdown in coastal areas.

As in the Escambia County Comprehensive Plan, this element needs to be more directed about setting priorities. Coastal and riverine areas are wellknown to be in critical need of protection. In this type of capital facilities element, service levels and maintenance precautions must be improved. The policies are so generally worded that they fail to convey the urgent situation in especially the sensitive areas. The recent formation of the Utilities Board is in excellent position to consider these needs.

The Conservation Element lists the following policies that offer a little more direction than is noted in the earlier described conservation elements:

o promote growth in areas where the soils are suitable for development.

o restrict and control excessive drawdown on the aquifer especially in the coastal areas.

o encourage the use of other than septic tanks especially in areas with poorly drained soils.

o promote open space and conservation uses in sensitive areas.

o strictly adhere to state conservation policies.

o recommend the development of appropriate soil, topographic, and floodplain studies to assist in conservation-related decisions.

o insist on site-planning and design characteristics so as to minimize or prevent environmental damage by all new developments in the County.

o utilize techniques to minimize urban and agricultural runoff.

o require the maximization of the overall topography, the particular physiographic characteristics, and particularly the coastline in developing residential areas.

o encourage the Planned Unit Development (PUD) concept as a means of protecting environmentally sensitive areas.

o adopt and promote conservation-oriented development techniques which utilize land efficiently and protect the character of the undeveloped woodland areas.

o permit only planned and orderly growth of public improvements so as to minimize environmental impacts.

o promote coordination between the County, Water Management District, Department of Environmental Regulation, Division of Forestry and Regional Council in the conservation of natural resources.

This element is very adept at pointing out that development projects should incorporate conservation measures. Moreover, it acknowledges that adverse impacts come not only from development activity but also from agricultural practices. The intent of this element is not apparent, however, in the zoning maps for the South Santa Rosa County Ordinance 86-16. In the maps, much of the land along the coastline is classified for uses potentially more intensive than the Planned Unit Development. This element should play an important role in determining future uses for lands adjacent to all bodies of water.

The Coastal Zone Element lists the following general policies:
o all public improvements in Santa Rosa County will be assessed by the appropriate officials as to possible impact on coastal zone resources.
o private development in Santa Rosa County will be reviewed at the issuance of building permits to review impacts on the coastal zone.

Thereafter, the Plan list policies under such categories as septic tank use, government coordination and management, domestic and industrial discharge, urban runoff, dredge and fill, natural vegetation, beach erosion, and aquifer drawdown. Those individual polic meaningful, specific direction upon which public officials should be able to determine difficult issues.

The Recreation and Open Space Element policies reinforce the priorities spelled out in previous elements:
o guide development in the County into patterns that offer maximum opportunities for the public to enjoy and benefit from valuable natural recreational and scenic resources.
o protect potential public recreational areas from encroachment of incompatible development in surrounding areas which would affect safety of access and or use.
o encourage the provision of open space and recreational facilities in all private residential developments. This could include the expansion of regulations to provide minimum standards of open space/facilities provision.

The last policy listed especially demonstrates how the Plan continues to point out that the scope of one element overlaps with the scope of others. Recreational facilities are not limited to parks; they can also be incorporated into subdivisions and elsewhere.

Finally, the Future Land Use Plan in the Santa Rosa County Comprehensive Plan relates to estuarine water quality. This strategic and detailed element submits several categories of

priorities to assure a flexibility in development choices. Too lengthy to enumerate here, the policies appear under the following areas: how the natural environment should be conserved; how compatible and coordinated development should be facilitated; and standards for location and general development.
The element's consistency with the new South Santa Rosa County Zoning map, however, is an indicator of how other portions of the County along the water will be classified. Since the existing land use map is quite general, and since this type of map is very useful in tracking growth patterns, the potential areas for development should be detailed in a future land use map which is not provided in the Plan.

The City of Gulf Breeze

Gulf Breeze was incorporated in 1961. Thereafter, it adopted its own codes, ordinances, and plans. Its proximity to the Gulf Island National Seashore and to Pensacola Bay and Santa Rosa Sound stresses the important role that this jurisdiction has in sound land use practices.

Subdivision Ordinance 49-62
This ordinance which controls subdivision development was first adopted in 1962 and amended in 1969 and 1983. It requires both preliminary and final plats. The plats must show all easements, particularly those used for drainage of stormwaters and runoff disposal.

Zoning Ordinance 16-74
In 1974 Gulf Breeze adopted its first zoning ordinance. It was amended in a variety of areas in 1975, 1982, 1983, 1984, and 1985. The most salient feature of this ordinance is its minimum landscaping requirements. It prescribes the use of landscaping as buffers between adjacent zoning districts and prohibits the removal of trees or shrubs on any public property. Generally, five percent of any total developed area must be landscaped. Permission for trimming and or removing trees must be obtained from the director of public works. Additional landscaping requirements are adopted under Chapter 23 of the city's and Development Codes.
Gulf Breeze's comprehensive zoning regulations allows some commercial districts, no industrial districts, as well as open spaces. Its many restrictions upon boat activity controls the use of the land bordering waterways.

Flood Hazard Ordinance 6-77
This ordinance, like those of the other juridictions, brings Gulf Breeze in compliance with the National Flood Insurance Program. Revisions have been made to reflect changes in the program.

Solid Waste Ordinance 1-75
It is unlawful to disposal of certain solid wastes on public lands, street, or waters. This ordinance provides for the franchising of garbage collection.

City Ordinance 2-73
This ordinance sets out impact study requirements which acknowledge the city's physical environment and its proximity to the Gulf Island National Seashore. With language declaring that this ordinance is the result of an existing emergency situation, the "environmental impact shall include adverse impacts, open space provisions, easements, drainage plans, and possible runoff problems. Included in the study shall be a) scope of project, b) population impacts and economic impacts, c) impacts upon public services and garbage."

Sewer Ordinance 4-71
The use of private sanitary systems, disposal, and the discharge of wastes are strictly regulated under this ordinance. The effort is to restrict the use of private septic tanks and privies. Pollutant standards and prohibitions on contamination by storm water are included.

The City of Gulf Breeze adopted its Comprehensive Plan in 1980, after having prepared a master plan in 1968. Those elements in the Plan which relate to estuarine water quality are: Sanitary Sewer, Drainage, and Potable Water; Conservation; Coastal Zone; and Future Land Use.

The Sanitary Sewer, Drainage, and Potable Water Element lists the following as its policies:

- o implement the 201 Plan.
- o construct a new interceptor system and pumping station for the purpose of conveying wastewater to new regional plant.
- o phase out Gulf Breeze treatment plant.
- o conduct an ongoing evaluation of the sewer system.
- o complete an extensive sewer system rehabilitation project.
- o phase out, over a period of years, all of the septic tanks in use.
- o extend collection lines to all City residents.
- o continue negotiations for a new transfer station to reduce transportation costs.
- o obtain a legally binding agreement from the County to assure free use of the Holley No. 2 landfill.
- o ensure the continuation of a suitable franchise arrangement with the Midway Water System.
- o continue to carry out proper operation and maintenance practices on the Gulf Breeze water distribution system.
- o effect the necessary maintenance techniques to sustain the

wells and pumps employed in the auxiliary system.
o assist in the provision of a second well for the Midway Water System.

This is by far the most explicitly guided capital improvement type element of those previously discussed. Since the Plan's adoption, many of these activities have been underway.

The Conservation Element policies are as follows:
o promote growth in areas where the soils are suitable for such development.
o regulate development in flood-prone areas so that they adhere to Federal Flood Insurance guidelines.
o Keep low-lying areas free from intensive urban development to minimize flood problems.
o promote open space and conservation uses in sensitive areas.
o encourage adherence to state conservation policies.
o encourage the development of appropriate soil, topographic, and floodplain studies to assist in conservation related decisions.
o encourage site planning and design characteristics which will minimize environmental damage by all new developments in the City.
o utilize, where possible and feasible, techniques to minimize urban runoff, including the retention of stormwater on site.
o encourage the maximization of the overall topography, the particular physiographic characteristics, and particularly the coastline in developing residential areas.
o utilize the Planned Unit Development(PUD) concept as a means of protecting environmentally sensitive areas.
o encourage coordination between the County, Water Management District, Department of Environmental Regulation, Soil Conservation Service, and the West Florida Regional Planning Council in the conservation of natural resources.

These policies stress coordination with a host of state, regional, and local agencies. Although the policies are quite general, at least the clause for "retention of stormwater on site," has been included. These policies are meaningful in how they relate to existing codes and ordinances.

The Coastal Zone Element policies for the City of Gulf Breeze are very similar to those of the Santa Rosa County Comprehensive Plan. The general policies listed below are supported by largely the same specific policies:
o all public improvements in Gulf Breeze will continue to be assessed by the appropriate officials as to possible negative impacts on coastal zone resources.
o private development in Gulf Breeze will be reviewed at the

issuance of building permits to review impacts on the coastal zone. Negative impact uses will be discouraged.

The specific policies are too lengthy; so they, like those in the Santa Rosa County Comprehensive Plan, will not be listed here. These policies are much more in line with the existng codes and ordinances adopted by the City, than those adopted by the County.

The Future Land Use Plan, in the way that the policies are presented, is also similar to the Santa Rosa County Comprehensive Plan. Policies for general development are guided by provisions for how the natural environment should be conserved, how compatible and coordinated development should be facilitated, how development costs should be minimized, how a desirable variety of land uses should be promoted, and how open space and sensitive ecological systems should be protected. This element too is consistent with the direction established in the City's codes and ordinances. The specific policies are too lengthy to be included here. This element also contains a future land use map, clearly and consistently depicting the policies discussed above.

City of Milton

Although Milton is not included in the Esacambia/Santa Rosa Coastal Resource Planning and Management Committee's study area, it is important to examine in this report by virtue of its proximity to the Blackwater River. This is the fifth and final local government discussed in this jurisdcitional framework section.

<u>Zoning Ordinance 747</u>
Zoning was first established in the City of Milton in 1972 to encourage appropriate uses of lands, regulate and restrict Planned Unit Development's, manage floodplain districts, provide support services, open spaces and adequate population densities. It has been amended once. The performance standards, like those in the Santa Rosa County Zoning Ordinance, pertain mainly to nuisance activities with some attention to environmental impacts. Its minimum standards are subject to those imposed by revised state and/or federal regulations. The lot coverage concept needs to be more clearly defined as a way of making the performance standards more meaningful.

Under one special article, this ordinance establishes a floodplain district. The intent is to preserve areas that are prone to flooding in their natural state or develop them in a prudent manner.

<u>Subdivision Ordinance 487</u>
This generalized city subdivision ordinance is less comprehensive than the zoning ordinance. Adopted in 1972, it

includes provisions for easements, drainage plans, and a topographical map. It pays particular regard to drainage of, sanitary disposal requirements for, and placing of mobile homes with the Health Department setting the necessary standards. It was amended in 1979 to deal with drainage improvements.

City Solid Waste Ordinance
Also adopted in 1972, this ordinance provides generally for the packing of solid waste in containers, their placement, and collection of refuse.

Erosion, Sedimentation, and Runoff Ordinance 606
This ordinance, adopted in 1978, requires that complete drainage plans be submitted prior to land clearing. The plan must detail storm sewers, ditches, culverts, catch basins, and settling basins among other drainage controls. Although individual single family and duplex homes are exempt from the required drainage plan, the lot must be cleared in a manner such that no runoff or siltation problem develops. Subdivisions are not exempt from any provision of this ordinance.

The City of Milton adopted its Comprehensive Plan in 1981. It is characterized by extensive mapping which makes interpretation of anticipated trends much more lucid than the trends in most of the other jursidictions discussed. The elements in the Plan that set policies which affect estuarine water quality include: Future Land Use; Sanitary Sewer, Solid Waste, and Drainage; and Potable Water; Conservation; and Recreation and Open Space. Since Milton is not a coastal community, it has no coastal zone element in its plan.

The Future Land Use Element's policies are broken down into three separate categories: residential, commercial, and industrial. The following summarizes those policies within each category which are central to this study:

Residential

o incorporate 100-year floodplain regulations into local land use ordinances.

o assess the feasibility of adopting local ordinances establishing the use of transferable development rights and public acquisition as alternative management tools for regulating flood plains.

o encourage the adoption of tree and landscape ordinances to prevent flood damage, and vigorously enforce the ersoion/sedimentation ordinance.

o residential development in wetlands should be avoided.

o soil information from USDA Soil Conservation should be investigated for compatibility to proposed use with existing soils before any construction permit is granted. Permeability limitations, shrink-swell potential, and load-bearing capacity should be considered.

o encourage residential developers to consider slope when selecting a site for development. Site plans should be reviewed to determine whether or not the design of structures, street, and storm drainage systems is sufficient.

o site plans for proposed residential developments locating in environmentally sensitive sreas should be reviewed and building permits issued only after the several factors (listed in the Plan) have been investigated.

Commercial

o require developers to submit proposed commercial projects locating in or adjacent to environmentally sensitive areas to local/state agencies for review, to insure compliance with State and National environmental law.

o adopt ordinances protecting the natural environment where State or Federal law may be weak or nonexistent when dealing with commercial development (i.e. sedimentation/erosion control ordinance).

o site plans for proposed commercial develoments locating in environmentally sensitive areas should be reviewed and building permits issued only after the several factors (listed in the Plan) have been investigated.

o adopt and enforce local ordinances which regulate commercial consturction in the 100-year floodplain, establish minimum performance standards for minimal or no damage, investigate the use of transferable development rights and public acquisition.

o commercial development in wetlands should be avoided.

o soils and slope information should be investigated (as in the residential portion).

Industrial

o regulate industrial development in the 100-year floodplain.

o industrial parks not requiring direct surface water access should be discouraged from locating within the 100-year floodplain boundary. Require such industries to examine alternative sites outside the 100-year floodplain.

o adopt and enforce local ordinances which require flood damage prevention facilities, and investigate the use of transferable development rights and public acquisition.

o support the existing federal regulations which control the storage of toxic materials in the 100-year floodplain.

o soil and slope information (as in the residential portion) should be investigated.

o encourage the coordination of all federal, state, and local permitting agencies in the establishment of a "streamlined" permitting system for new industrial development.

o require compliance with the siting requirements and standards of the Federal Clean Air Act and Chapter 17-2, Florida

Administrative Code before issuing a building permit for industrial development.

o protect estuarine areas and other marine habitats from adverse environmental impacts resulting from improper industrial development.

o protect industrial districts from encroaching development of residential and other incompatible land uses.

o facilities such as warehouses, sewage treatment plants, and city garages should be located in industrial or buffered areas to lessen adverse impacts on other land uses.

Many of the policies reflect the need to adopt ordinances which are long overdue, which other jurisdictions in the two county study area have adopted. Other policies redundantly express the necessity of abiding by federal and state laws. The direction of the policies as a whole, however, is supportive of vigorous enforcement of sound environmental protection.

One troublesome aspect of this element is the lack of buffer along the Blackwater River as shown on the future land use map. Expansion of intensive classifications such as industrial and commercial uses are shown adjacent to the river. Moreover, the industrial zone expanded in the southeastern portion of the city conflicts with the open space designated for that same area under the Conservation Element. This use must be reconciled in order that a consistent and environmentally sound strategy is implemented.

The Sanitary Sewer, Solid Waste, Drainage, and Potable Water Element has enumerated many very specific policies. Those most relevant include the following:

o upgrade the treatment plant and expand its capacity to 2.5 MGD.

o install interceptor system.

o through a sewer system evaluation, determine precisely the problems in the collection system.

o perform a sewer system rehabilitation project.

o insure that wastewater effluent discharged into the Blackwater River meets DER and EPA standards.

o explore sources of funding for extension of collection lines into new areas.

o phase out septic tanks in areas where sanitary sewer service is available.

o since the responsibilities for operation and maintenance of the landfill site reside with the county, continue to work closely with county officials to insure that proper disposal techniques are efficiently executed.

o as city growth occurs and new areas are annexed, insure that the city's sanitation department is capable of serving new customers.

o study specific drainage problems and determine whether or not improvement projects are feasible.

o insure that plans for provision of proper drainage facilities accompany each proposal for new development.

o use the 208 Areawide Waste Treatment Management Plan, Management Handbook to review existing drainage ordinances and develop new ordinances consistent with the 208 Clean Water Plan.

o revise subdivision regulations to allow the use of grass swales where feasible.

o develop an auxiliary system sufficient to meet emergency demands.

o continue system mapping.

The policies in this element are more exacting than those capital improvement related elements in the other plans. This gives local public officials firmer ground upon which to implement responsive environmental controls.

The Conservation Element lists the following policies:

o promote growth in areas where soils are suitable for development.

o discourage the use of septic tanks with poorly drained soils.

o promote open space and conservation uses in sensitive areas.

o encourage adherence to state conservation policies.

o encourage the development of appropriate soil, topographic, and floodplain studies to assist in conservation related decisions.

o encourage site planning and design characteristics which will minimize environmental damage by all new developments in the City.

o discourage intensive development around low lying river flood plains to minimize flood problems.

o encourage the maximization of the overall topography, the particular physiographic characteristics, and particularly the coastline in developing residential areas.

o utilize the Planned Development Project concept as a means of protecting environmentally sensitive areas.

o encourage planned and orderly growth of public improvements to minimize environmental impacts.

o encourage coordination between the City of Milton, Santa Rosa County, and the West FLorida Regional Planning Council in the conservation of natural resources.

o implement the 201 Facilities Plan.

o adopt the 208 Clean Water Plan.

Although this element covers all the general areas, it lacks the specifics to carry out a meaningful conservation agenda. Also, despite that fact that coordination is stressed, internally the document itself contradicts this policy. The "conservation areas" along the Blackwater River are also those areas which have been designated for intensive development in the Plan's Future

Land Use Element. Almost a duplicate of the Gulf Breeze Conservation Element, this element does not include the meaningful clause in the urban runoff policy regarding "retention of stormwater on site."

The Recreation and Open Space Element policies that pertain to estuarine water quality management are highlighted in the following:

o coordinate the need for recreational space identified in this element and the 1976 Recreation Plan for Action with the Future Land Use Element.

o encourage preservation of open space along the Blackwater River north of the L&N Railroad and promote the development of a marina in the area.

o as new areas are considered for annexation into the City, investigate the purchase of sites for recreational purposes.

o locate neighborhood parks adjacent to public schools and on school grounds where possible.

o investigate all the sources listed in this element for availability of funding for recreation and open space improvements in Milton.

o encourage establishment of an intergovernmental recreational planning committee with representatives from the cities in the County, the County, the public school system, and any other significant recreational organizations.

In this element, as in the Conservation Element just discussed, the notion of coordination is confused. Areas which are proposed for recreation in this element are designated for industrial and commercial uses on the Future Land Use map. Also, while this element specifies areas adjacent to public schools and school grounds as prime areas for locating recreational facilities, it should also specify areas adjacent to the Blackwater River. This intent should be verbally expressed as plainly as it is graphically expressed.

Section-3 Estuarine Degradations & Land Management Relationships

Section 3. Estuarine Degradations and Land Management Relationships

3.1 Introduction

Estuaries are unique environmental features that represent an interface between fresh and marine waters. Because of the gradient of salinities present, estuaries contain a wide range of habitats that harbor a diverse and abundant assemblage of flora and fauna. Many of these habitats act as a nursery ground and refuge for a large number of important commercial and sport species. Over 90% of the fish species present in nearshore Florida coastal waters utilize estuaries during at least a portion of their life cycle.

It is well documented that estuaries are highly productive areas (e.g., Odum, 1959, 1960). Unfortunately, estuaries and their adjacent lands have physical and visual attributes that attract residential, industrial, and commercial development. In most situations, human activity and natural functions are incompatible, with the environment typically impacted to some degree. Future prospects for estuarine resources do not appear much better because of increasing pressure from a growing population that is concentrated primarily along the coastal region.

Estuaries are particularly sensitive to pollution inputs. Estuaries may be viewed as repositories of pollution activity occurring upstream. One factor contributing to this sensitivity is that the area of the waterbody is usually much smaller compared to that of the adjacent land masses, therefore pollutants entering the estuary are concentrated into a smaller area. Physical and chemical processes within the estuary also are major factors.

Upland activities can directly and/or indirectly affect estuarine resources. For example, dredging nearshore sediments can directly destroy seagrass beds by physically removing the plants but it may also indirectly destroy nearby beds by increasing the turbidity of surrounding waters. It may also affect other habitats in a variety of ways. Many times the loss or degradation of an estuarine resource may be the result of the interaction of many individual land-based causes or the cumulative effects of many "small" impacts that taken alone would not produce a significant degradation.

The recognition of specific recurring problems within the estuarine system and their ties to upland activities provides an historical basis with which to develop land management practices and regulations to reduce the future threat of further degradation. In addition, nonuniform regulations or policies in the system can be identified that pose potential problems.

The Pensacola system has experienced a number of environmental degradations (see Section 1) that are attributable to various upland activities by a number of investigators. These upland activities, in turn, can be analyzed in terms of land management practices throughout the region.

3.2 Methodology

Several investigators have attempted to examine the effects of land use practices on estuarine resources in other systems (e.g., Long Island Sound - Beltrami and Carroll, 1978). Many have reached similar conclusions concerning the difficulty of working on such a complex problem. For example, Maiolo and Tschetter (1981) stated the following: "None of the published reports we reviewed provided specific estimates of damage to estuarine fisheries due to actual episodes of coastal zone development. As such, coastal zone and resource managers are left to make policy by the process of extrapolation, which can be quite risky, or even worse, on the basis of general impressions." and "... we are constrained by limited data which, nevertheless, should be of importance to resource managers. It is our view that we should present the data now, limited as they may be rather than await the results of future research, while, in the meantime, social and economic costs in our coastal zones continue to mount." We ran into similar difficulties during this investigation: limited data, the absence of historical land use data, and statistical limitations, in particular, that made it hard to generate concrete cause-and-effect correlations between land uses and estuarine degradations.

As previously mentioned, we viewed the problem of estuarine degradations within the Pensacola system in an historical perspective. Doing this, we encountered the first problem. There is a general lack of environmental data prior to 1970, with the exception of aquatic vegetation distributions (Figure --). In addition, many available reports covered only specific geographical areas or specific problems at a single time period that provided only a snapshot view of a portion of the system.

Given the data gaps and statistical problems we encountered with a quantitative approach, we took a qualitative view of the problem. We based our conclusions and recommendations on the results of previous investigators working in the system, many of whom noted the effects of particular land uses on estuarine resources and most of whom had a greater understanding of the ecological functionings of the system. In other cases, we could relate an estuarine degradation to a particular alteration in an environmental condition(s) (e.g., increased turbidity) based on work in other systems. Note that this is not to be equated as a "cause and effect" situation. The data do not allow such a conclusion. We then attempted to relate management practices. or a lack of regulatory mechanism(s) to the change in the natural environmental condition which in turn affects the estuarine resources:

Regulatory-------> Environmental-------> Estuarine
mechanism condition resource

In some instances, direct relationships could be noted, for example dredging through a grass bed obviously destroys a segment of that habitat. However, many times several potential causes may have been indirectly responsible for an observed degradation. For example, the demise of the seagrass in the Pensacola system has been tied primarily to increased turbidity caused by a variety of factors such as stormwater runoff, industrial input, nutrient loading, and others. Therefore, one must determine which management practices affect these environmental factors. As a first step, it is important to identify the environmental conditions that affect estuarine resources. The following relates the six degradation categories noted in Section 1 to possible causative environmental factors:

Estuarine Degradation	Causative Environmental Factors
Aquatic Vegetation Declines	Increased turbidity Dredging/Filling Marinas piers, and docks
Water Quality Declines	Wastewater inputs Industrial inputs (heavy metals, synthetiz organics, and nutrients) Stormwater runoff (heavy metals, synthetic organics, and nutrients) Lack of wetland buffer/filter
Estuarine Sediment Contamination	Dredging/Filling Industrial inputs Stormwater runoff Erosion - change in sediment type Solid waste disposal
Shellfish/Finfish Declines	Toxins Low DO (water quality) Habitat loss Increased turbidity, esp shellfish Lack of food Stock depletion - overharvesting
Shoreline Erosion	Disruption of natural transport system Sea-level rise

Bayou-specific Problems	Exceeding assimilatative capacity Low flushing capabilities Nutrient loading Toxins Summer stress conditions Wetland loss Watershed alteration

The regulatory mechanisms or topics discussed in Section 2 can be variously assigned or related to a number of these causative environmental factors. It should be pointed out however that the degree (in actual quantitative terms) to which each mechanism (e.g., stormwater management) actually affects an environmental condition (e.g., turbidity) is unique to an individual estuarine system given the multitude of factors (e.g., impervious surface, pollutants present, slope of terrain, size of receiving water body, and general hydrology) that are involved in every segment of the bay system. In addition, there are the hard-to-measure factors, such as the consistency of compliance and enforcement, that come into play and can be equally important.

We related the regulatory mechanisms identified earlier in Section 2 to changes in environmental conditions in the following manner (adapted from Koppelman, 1976; Rogers, Golden and Halpern, Inc., 1985):

Regulatory Mechanism	Affected Environmental Condition
Stormwater Management	Turbidity Nutrient Levels DO Levels Sediment size and type Habitats Shellfish/finfish productivity
Shoreline Protection	Sand transport
Habitat Protection	Dunes Wetlands Submerged vegetation (seagrass) Beaches Shellfish/finfish productivity
Septic Tanks	Nutrient levels DO levels Shellfish productivity

Marina Siting	Water quality Seagrass declines
Solid Wastes	Toxins
Floodplain Management	Habitats (especially wetlands) Turbidity Sediment size and type
Land Development Codes	Habitats Water quality Shellfish/finfish productivity
Dredge and Fill	Habitats Turbidity DO levels Toxins Sediment alteration Shellfish/finfish productivity

As is clearly evident from the above table, the regulatory mechanisms that are in place or available for upland regions can affect more than one environmental condition simultaneously. Also, the effects of various upland activities may interact to produce adverse effects. As more data are collected on estuarine systems in general and the Pensacola system specifically, these relationships may become more clear. One way to simplify the problems and reduce the variability encountered in working with a large, complex estuarine system such as Pensacola Bay is to make sure that all the upland regions surrounding the water bodies are regulated in a similar manner or within a similar range of standards. Therefore, as environmental conditions change in the system the regulations and standards can be adjusted on a region-wide basis to correct any problems.

3.3 General Trends and Relationships

After analysis of the available data on the estuarine resources and degradations within the Pensacola system, several general historical trends emerged:

(1) Residential and industrial development and their accompanying activities have had significant detrimental impacts upon the seagrasses through both individual and synergistic effects. The inappropriate placement of some industries along some sections of the system with poor circulation has contributed to many of the problems. For example, investigators have reported that several factors probably contributed to seagrass declines in the system. These include: industrial discharges, dredging and filling, beachfront alteration, nonpoint discharges, and general watershed changes. Most of these factors contribute to increased turbidity in the system which has been shown to be a primary cause of seagrass bed decline. Although there has been a general comprehension of the extreme importance of these habitats to the system since at least the early 1970's, actual protective measures have not yet been implemented.

(2) Many of the numerous fish kills that have been noted throughout recent decades in the system were the result of artificially stressful conditions (e.g., nutrient loading and decreased DO levels) superimposed upon naturally stressful conditions (e.g., low DO levels and low freshwater inputs) that are most prevalent during the warm summer months.

Where once many areas were well-suited for septic tanks, this type of sewage treatment is having detrimental effect on nearby surface waters. Septic systems have been linked to numerous waterborne disease outbreaks. Septic tank systems work well in rural low density areas with suitable soils. Given the strong growth pressures, the estuarine area is rapidly becoming densely populated. In a number of cases, sewage treatment plants have been operating at overcapacity especially during the summer which is a peak season for visitors. The declines in oyster, crab, and shrimp productivity in the area can be attributed to general declines in water quality and loss of suitable habitats or nursery grounds.

(3) The northeast region of Escambia Bay has been the site of numerous water quality degradations (low DO levels and high nutrient and toxin inputs) and sediment contamination problems due to industrial point source discharges. These have been clearly evident as fish kills and shoreline vegetation changes during the early 1970's and the last couple of years.

(4) In general, water quality conditions in the system have improved over those present in the mid-60's to mid-70's. This

may be attributed to stringent federal and state regulations and a greater awareness of the problem throughout the system. Nevertheless, Young (1985) noted that this trend of improvement was not continuing. This has become evident more recently (late summer 1986) by two large fish kills that have been noted in Bayou Chico and the northeast corner of Escambia Bay.

(5) The bayous surrounding the bays historically have been the most sensitive regions of the system. They are the most susceptible to perturbations by development in their immediate vicinity and its accompanying pollution. This is clearly demonstrated in the case of Bayou Chico which has experienced excessive residential and industrial development over the years.

(6) The shoreline erosion problems present along the northern shore of Santa Rosa Island appear the result of a natural rise in sea level and man-made structures that have altered the littoral sand-transport system along the shoreline.

Many of the aforementioned observations can be directly or at least indirectly tied to the general hydrodynamic regime of the system. As noted in Section 1, the system as a whole has poor circulation and consequently a very slow flushing a time due to several physical factors. This causes pollutants that enter the system to remain for a long time. Physical and chemical processes remove a variety of pollutants from the water colum to the sediments where they may be stored for various time periods. In the case of bayous, the flushing times are also very high. As a result, the bays and bayous can undergo seasonal physical fluctuations such as summer stratification of the water column with very low DO levels in the bottom layers that stress the ambient fauna.

We noted repeated recommendations and concerns for the declining estuarine resources in the system through many reports. The urgency of the situation has, however, not meet with the appropriate response on the local government level. Local governments have not addressed these concerns for several different reasons. Many officials continue to rely on anitquated analytical techniques. Often unreliable and inconsistent data are the basis for findings upon which officials will approve a project or activity. The water quality standards have been set with assimilative capacity not with restoration in mind. Before an effective regulatory strategy can be developed to stem the decline of estuarine resoures, a greater awareness and appreciation of the severtiy of the problems is necessary.

Section-4 Recommendations

Section 4. Recommendations for Corrective Action

The recommended corrective measures are divided into three categories: (1) general recommendations; (2) specific recommendations for improved land management at the local level that address the six estuarine degradation categories noted, and; (3) gaps in data and knowledge of the system that need attention. These measures are germane to both the recommendations made in the Resource Management Plan, as well as the minimum criteria for local government comprehensive plans adopted under 9J-5, F.A.C.

General.

(1) Joint venture solutions to mutual problems between levels of government and private enterprise should be increased where feasible. Of particular note is the coordination of data collection for the Bay Area Resource Inventory Program (BARIP) program between the involved agencies and local industries which have compliance monitoring programs in place for NPDES permits. This would enable these separate entities to pool their information and ensure overlap in sampling stations and techniques. It would also provide more oversight toward improving conditions.

(2) Greater public awareness of the problems of the system and voluntary methods to improve conditions within the system. Several principal investigators for estuarine studies claimed that public awareness was a crucial aspect in spearheading their respective resource management efforts. The following are examples of how the public could be informed:

a. A resident's guide to shoreline management should be developed to instruct property owners in the proper care and maintenance of waterfront property (e.g., the proper use of pesticides and fertilizers on waterfront lawns, etc. and proper disposal of toxic household chemicals). This type of guide has been distributed by the Maryland Coastal Zone Program.

b. A guide to be distributed at marinas, to inform boaters of the sensitivity and importance of the seagrass beds and measures to be taken to avoid destruction of this habitat.

c. A comprehensive program in the school systems to teach the importance of the system's environments and ways to protect the sensitive habitats. The City of Sarasota has implemented this with assistance from the federal Office of Coastal Zone Management.

Specific Recommendations Based upon Estuarine Degradations.

(1) Adopt zoning throughout all unincorporated areas in Escambia

County to restrict the placement of nonwater-dependent uses near the shoreline. Eliminate untreated industrial discharges and runoff in general from directly entering the waterways by zoning industrial uses in areas not adjacent to the waterways and by zoning buffers between the industrial use zones and the waterways.

a. This measure would assign to land appropriate uses, densities, intensities, and performance criteria (stormwater retention, erosion control, effluent discharge levels, etc.). This detailed system would enable public officials to understand better and forecast more accurately development patterns and their impacts. The use of appropriate siting would minimize pollutants from entering the system. For example:

1. New industrial land use classifications would not be placed along the bays, bayous, or rivers unless absolutely necessary.
2. Non-water dependent commercial uses which would otherwise adversely affect the shoreline environment should be prohibited.
3. In general, cluster residential development away from the water's edge.

(2) Existing land uses must be mapped and periodically updated so that an accurate inventory can be available for water quality modeling and analyses of the system. Above and beyond the minimum criteria adopted under 9J-5.006(1), Florida Administrative Code, is the following:

There should be uniformity in map coding throughout all jurisdictions in the system so that a comprehensive view of the entire system can be obtained without a number of interpretations needed. For example, district could be viewed in terms of a series of watershed management districts. Comparable land use terms could be used since the watershed spans more than one political jurisdiction.

(3) All areas must have future land use maps, as required by 9J-5.006, Florida Administrative Code.

a. The specific zoning recommendations described above should be graphically portrayed, in accordance with 9J-5.006(3) and 9J-5.006(4).

b. Some areas need to reconcile incompatible land uses shown in separate elements of a comprehensive plan. For example, Milton has a conflict showing an industrial district and conservation district in the same area adjoining the Blackwater River.

(4) Establish a sensitive vegetative buffer area along waterways and bay and bayou shorelines to reduce sedimentation, turbidity, and nutrient loading in the system. This would also provide habitat protection for shoreline vegetation and animal communities.

a. Extend beyond the bayou and bay corridors, recommended for protection in the Resource Management Plan, to include rivers and most streams in the two-county region.

b. Establish specific setbacks for each component of the system

c. Establish high performance standards for development within this sensitive area in order to reduce pollutants (from both point and nonpoint sources) from entering the system. For example:

1. Stormwater management
   - extra ordinary (> .5 in) water retention areas for stormwater runoff for development along the waterfront
   - less impervious surface
   - preserve as much native vegetation as possible, especially adjacent to waterways
2. Site design
   - minimize the clearing of vegetation and disturbance of soil by restricting clearing to the "footprints" of site structures and to that necessary for drainage and traffic safety in order to minimize erosion
   - minimize grading
   - maximize on-site retention of sediments by leaving substantial buffer strips of vegetation down slope of disturbed sites
   - allow space for the installation of sediment-trapping devices close to disturbed areas
3. Septic tanks
   - install septic drainage fields as far as possible from surface waters and place in only proper soils

(5) Stress coordination between the utility board and authorities and HRS with regard to septic tank location, installation, and regulation. This would improve implementation of HRS' septic tank rule, known as 10D-6, Florida Administrative Code, and eventually reduce nutrient loading and the potential for pathogens to enter the system.

a. The septic tank regulator is apprised of available sewer service.

b. Minimize potential septic system installations in unsuitable areas such as inappropriate soils and nearby surface waters.

(6) Adopt an adequate public facilities ordinance to reduce residential effluents and toxic runoff from poorly managed solid waste facilities.

a. Require close accounting of service levels and siting practices. Service providers would be less inclined to be over-extended because development order approval is commensurate with existing facilities' capacity.

b. Expand Resource Management Plan's recommendation to

establish utility authority/board beyond southern "study area" to follow the sensitive area buffer/corridor.
c. Manage public wastes more efficiently.

(7) Adopt a provision in all land development codes that ensures that a consistently rigorous site plan review is conducted. Prepare a checklist reflecting all the requirements with which a development project must comply; for example: setbacks, drainage system, existing vegetation to be preserved, additional landscaping, and calculation of total impervious surface. This approach gives greater assurance that the review process is not only thorough, but consistent throughout the jurisdiction.

(8) Work towards establishing a watershed management district
a. Enlist DER's aid in preparing supporting ordinance to document the layout of watersheds within the two county area. This would work towards reducing nonpoint source pollution by managing and confining stormwater runoff in its natural domain.
b. Floodplain management could be a subset of this district where higher performance standards are set. This would protect wetlands from point and nonpoint source pollution, reduce erosion and nutrient loading into the nearby waterways.

(9) Adopt a landscape ordinance which shall establish higher standards for the floodplain and higher still within the sensitive area buffer zones, especially adjacent to the bays and bayous where the wildlife habitat is most diverse and most sensitive to all types of pollution. This would encourage habitat protection and stormwater retention.

(10) Marina siting
a. Included in the recommendations of the Resource Management Plan, the local governments should consider prohibiting the placement of marinas over existing seagrass beds, especially within the Santa Rosa Sound. The extreme importance of this habitat to the estuarine system has been established and expressed by numerous investigators. Several factors contribute to seagrass decline around such structures: reduced light for photosynthesis especially directly underneath the structure, petroleum pollution from outboard motors, increased turbidity from boat movement, and direct cutting of seagrass blades by props. Provisions should be made to exclude the dredging of and the dumping of any fill onto any grassbed for the establishment of a channel to an existing marina or dock. The same standards may be applied to docks and piers that function in a similar manner to marinas.
b. Preference should be given to sites which have been disturbed previously as opposed to sensitive natural areas. Expansion of existing marina facilities should be encourages over the development of new facilities.

(11) Enact special habitat protection measures for seagrass beds.

At a minimum, increase shallow boat channel markings to guide inexperienced boaters away from vegetated shoals and boat ramp signs to increase boater awareness of potential damage they may cause outside these areas.

(12) Have comprehensive plan policies reflect the level of performance addressed in new districts and ordinances. Use "shall" instead of "encourage" or "should" in the wording of plans.

(13) Shoreline protection

a. A long range (50 year) consideration should be incorporated into shoreline protection policies given the projections for sea-level rise in the vicinity.

b. The placement of structures, such as bulkheads, along the shoreline should be prohibited in most instances.

(14) A restoration trust fund to be set up with fines collected from violators of various habitat protection measures could be used to restore seagrass beds and other important habitats in the system.

<u>Data Needs.</u>

(1) Reassessment of the adequacy of the present pollution control standards given the reversal in the trend of improvement in the system's overall quality.

(2) An assessment of cumulative effects, especially docks and marinas on various waterbodies in the system. In particular, an examination of the cumulative impacts of the numbers of docks and marinas on the seagrasses along the northern shore of Santa Rosa Sound. Also, less visible habitats such as soft-bottom unvegetated sediments should also be examined in detail because they comprise the majority of the estuary and are vital to its physical, chemical, and biological functioning.

(3) A general assessment of shellfish and finfish stocks with more studies on the biology and natural history of the important recreational and commercial species in the system so that the physical data collected on the system can be more effectively related to fluctuations in these resources.

(4) The impacts and amounts of groundwater pollution into the estuaries and bayous.

Section-5 Applicability to other Systems

Section 5. Applicability to other Estuarine Systems

One of the objectives of this investigation was to create a procedure to guide the analysis of estuarine degradations and land management practices that could be applied to other estuarine systems within the State of Florida. More specifically, the methodology would be one that could be applied to Resource Management Plan areas to aid in the evaluation of the effectiveness of the plan. It could also be one that could be used for analysis of land use practices around aquatic preserves.

The general methodology we developed is outlined below:
(1) generation of estuarine data base;
(2) identification of recurring or persistent degradations of estuarine resources;
(3) identification of sensitive areas or habitats within the estuary;
(4) identification of all jurisdictions within the system;
(5) identification and analysis of all plans affecting the estuary or its components;
(6) determination of uniformity of goals and policies for system;
(7) identification of regulatory mechanisms that may affect resources directly or indirectly;
(8) determination of uniformity of regulations around system;
(9) identification of past recommendations and their implementation into the regulatory framework;
(10) identification of the relationships between estuarine degradation and land management practices;
(11) generation of recommendations for corrective action
 a. policy changes
 b. ordinances
 c. coordination between users of the system, and;
(12) identification of data needs to direct future research within the system.

There will be similarities between the present analysis for the Pensacola and other systems in the Florida. We have delineated the federal and state regulations dealing with estuarine resources. Overall, the federal and state regulations will be uniform (in a vertical sense) throughout all the water bodies, although there will be the question of uniform enforcement. It will be on the local level where differences will be identified (in a horizontal sense) and where the recommendations will be directed.

There are some important concepts to consider when using the procedure to analyze other systems. First, the hydrodynamics of the system will be extremely important. Second, it is critical to note that there may be different overall management goals in different systems. For example, the Apalachicola Bay is very dependent upon fishing and oystering and its residents have a different value structure for its estuarine resources than a more visually-oriented area such as Panama City Beach. Therefore, the two will have different goals for management of its estuarine resources. Another important factor is the community perception of resource degradation and commonality of goals. For example, does the majority of the population view the system as degraded and in need of better regulation. It is important to recognize whether these goals are consistent throughout all jurisdictional entites and plans. It has been our experience that they often are not.

Section-6 Comprehensive Bibliography

Section 6. Comprehensive Bibliography

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Appendix A.

GLOSSARY

aerobic - living, active, or occurring only in the presence of oxygen.

anaerobic - occurring in the absence of free oxygen.

anoxic - oxygen absent.

benthos - organisms that live on or within bottom substrates.

biochemical oxygen demand (BOD) - The quanitity of dissolved oxygen, measured in milligrams per liter (parts per million), required to stabilize decomposable organic matter by aerobic biochemical action. This quantity is determined by diluting a sample with water saturated with oxygen and measuring both immediately and after a five-or ten-day period.

cumulative effects - The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects. Although each action may seem to have an negligible impact, the combined effect can be severe.

depuration - The process whereby shellfish such as oysters and clams rid or cleanse themselves of pollutants.

detritus - partially decomposed organic matter (e.g., plant material) that represents a food source to many estuarine organisms.

dissolved oxygen (DO) - Atmospheric oxygen that is dissolved and held in solution in water. Only a fixed amount of oxygen can be dissolved in water at a given temperature and atmospheric pressure.

diurnal tides - one tidal cycle (high and low tide) per day.

effluent - the outflow of water (with or without pollutant), as from a lake, river or pipe.

epifauna - In benthic communities, those organisms living on the substrate surface, either attached or free moving.

epiphyte - micro or macroscopic plants that live on the surface of a substrate.

estuary - A semienclosed coastal body of water having a free connection with the open sea and within which sea water is measurably diluted with fresh water.

euphotic zone - the amount of surface waters that receives sufficient light for photosynthesis to occur.

fecal coliform - Bacteria that are present in the intestines or feces of warm-blooded animals and that are often used as indicators of the sanitary quality of water. Their degree of presence in water is expressed as the number of colonies per 100 milliliters of the sample. The greater their number, the higher the degree of pollution that is indicated.

flushing time - the amount of time for a pollutant entering a water body to be removed by natural forces such as tides and currents.

halocline - a salinity gradient.

infauna - In benthic communities, those organisms that dig into the substrate and construct burrows or tubes.

macrofauna - Often referred to in benthic communities as those organisms that will be retained on a 0.50 mm mesh sieve.

macrophytes - plants visible to the naked eye.

mean high water - the average height of the high tides over a 19-year period.

mean low water - the average height of the low tides over a 19-year period.

nonpoint source pollution - pollution that is generated over a relatively wide area such as a city or cropland rather than at a specific place, and that is discharged into receiving waters at irregular intervals as a consequence of storm runoff.

nutrients - Essential chemicals needed by plants or animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and the growth of excessive numbers of algae. Some nutrients can be toxic at high concentrations.

point source pollution - pollution originating at a particular place, such as a sewage treatment facility. In contrast to nonpoint source pollution, point source pollution tends to occur more or less continuously.

prinicipal nutrient index (PNI) - a water quality criterion incorporting a number of nutrient concentrations in one number. The method was developed by Harkin (1974).

pycnocline - a density gradient

runoff - the part of precipitation that appears in surface streams after having reached the stream channel either by surface or subsurface routes.

salinity - a measure of the quanitity of dissolved salts such as in seawater.

surface irradiance (SI) - the quantity of light present at the surface of the water.

synergism - an action as a result of several different agents such that the total effect is greater that the sum of the effects taken independently.

tidal range - the difference between high and low tide levels.

toxic - poisonous, carcinogenic, or otherwise directly harmful to life.

turbidity - A measure of the amount of material suspended in the water column. Increasing the turbidity of the water decreases the amount of light that penetrates the water column. High levels of turbidity are harmful to aquatic life.

Appendix B.

ABBREVIATIONS

BARIP = Bay Area Resource Inventory Program

BOD = biochemical oxygen demand

DDE = dichloro-diphenyl-ethane

DDT = dichloro-diphenyl-trichloroethane

DER = Department of Environmental Regulation

DNR = Department of Natural Resources

DO = dissolved oxygen

ECUA = Escambia County Utility Authority

g = gram

kg = kilogram

km = kilometer

l = liter

m = meter

mg = milligram

mgd = million gallons per day

MHW = mean high wtaer

MLW = mean low water

MPN = most probable number

N = nitrogen

NWFWMD = Northwest Florida Water Management District

P = phosphorus

PCB = polychlorinated biphenyl

PNI = principal nutrient index

ppm = parts per million

ppt = parts per thousand

REMOTS = trade name for sediment profile camera combined with computer image analyzer

SRIA = Santa Rosa Island Authority

STP = sewage treatment plant

TOC = total organic carbon

ug = microgram

WWTP = wastewater treatment plant